THE ROLE OF METAPHOR IN DESIGN EDUCATION PEDAGOGY

ALLAN WELCH Dip.I.A.(Adv.), Dip.Ed.

CENTRE FOR EDUCATION

Submitted in partial fulfilment of the requirements for the degree of Bachelor of Education (Honours), University of Tasmania, October, 1991.

ACKNOWLEDGEMENTS

My thanks to my supervisor Dr. Bevis Yaxley whose enthusiasm and unflagging encouragement sustained me in the formative stages of this study. His constructive criticism and suggestions at crucial stages thereafter contributed much to the development of my hypothesis.

I have been privileged to have worked with Dr. Yaxley and he has my gratitude for bringing me to a new understanding about pedagogical reasoning, particularly through the use of metaphor as a tool for thinking.

Finally, I must formally acknowledge that this dissertation contains no material which has been accepted for the award of any other higher degree or graduate diploma in any tertiary institution and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, except where due reference is made in the text of the dissertation.

A. Welch.

ABSTRACT

The classroom implementation of the Tasmanian Certificate of Education from 1990 has created a need for teachers to critically examine their respective pedagogies in the light of its syllabuses' aims, objectives, and assessment procedures. Syllabuses written for the Materials, Design and Technology (MDT) curriculum area now prescribe a fuller expression of the design education intention than that which was more liberally expressed in former School Certificate syllabuses for Manual Arts. The intention of design education is firmly stated in all MDT syllabuses, namely: *Applied Design, Design in Graphics, Design in Metal, Design in Plastics,* and *Design in Wood.*

Design education has been expressed in various forms in school subjects akin to MDT in the English-speaking world for 100 years and during that time a conflicting relationship between a tool skills orientation and a design based orientation of the subjects' pedagogies has emerged: each is regarded as being mutually exclusive. Much of the debate has focused on the pedagogical application of the design process; debate about whether tool skills acquisition can be addressed simultaneously with design processes through students' exploration and discovery of them, or whether tool skills development is a necessary pre-requisite for design activities which must be purposefully developed in an a priori fashion.

This practitioner-oriented study focuses on *Design in Metal* and demonstrates the power of metaphor as a tool for thinking by metaphorical analysis of the conflicting views through examination of

the conventional pedagogical model of the design process. By demonstrating its limited utility for teaching in design education, the analysis reveals the assumptions supporting the conventional design process and proceeds to re-set the problem. Problem setting then frees design education language and thinking from their conventional interpretations and generates a more pedagogically appropriate alternative design process model based on an alternative metaphor.

Central to the study is an examination of the power of metaphorical analysis to free thinking from its cultural limitations, facilitating problem-setting, rather than problem-solving, in pedagogical reasoning. This focus is linked to an overview of the evolution of the conflict within design education in MDT and kindred school subjects, supported by practitioner anecdote and narrative, all of which contribute to the establishment of a context for an implementation of the alternative design process model in a case study.

The study concludes by demonstrating that the conventional design process model's limited pedagogical utility is attributable to its underpinning by a dead metaphor, and consequently, explains its failure to establish itself as a satisfactory pedagogy in design education. The alternative design process model developed and described here claims to simultaneously and dynamically match students' various stages of cognitive development and tool skill acquisition in design activities, thus providing teachers with a more flexible and appropriate pedagogy for design education in the classroom.

CONTENTS

CHAPTER ONE

PEDAGOGY, METAPHOR, AND DESIGN EDUCATION

> ...we may, in discourse, state a fact of which we are aware and then find that we have stated, by implication, further facts of which we were not aware until we analysed our assertion (Langer, 1967, 114).

All teachers develop a pedagogy; a set of plausible, coherent and operationally credible schemata which is central to the act of teaching. A teacher's pedagogy embraces

> ...ways of talking, showing, enacting, or otherwise representing ideas so that the unknowing can come to know, those without understanding can comprehend and discern, and the unskilled can become adept (Shulman, 1987, 7).

Sometimes pedagogy can be implicitly expressed as either an approach to or a style of teaching, or it may be explicitly stated as a model or method of teaching (Brady, 1985). In any case, either sub-consciously or otherwise, there is a process through which a teacher's operational understanding emerges; a process which may be expressed as a model of pedagogical reasoning and action involving several identifiable stages (Shulman, op. cit., 15). Amongst these stages, the process of transforming subject matter as understood by the teacher to that accessible to the student involves a '...representation of the ideas in the form of new analogies, metaphors, and so forth' (ibid., 16).

The importance of the notion of metaphor being applied to the development of pedagogy in terms of representing ideas for students is paralleled by its significance in developing the teacher's understanding of the act of teaching: 'The warranted function of metaphor, apart from its use in poetry, is in the context of heuristics: the formation of an idea or hypothesis to be studied, perhaps tested' (Pratte, 1981, 311). Increasingly, metaphor is becoming accepted as being '...central to the task of accounting for our perspectives in the world: how we think about things, make sense of reality, and set the problems we later try to solve' (Schon, 1979, 254).

Metaphors provide opportunities to analyse language to discover meaning and understanding which may not be available to us through literal interpretations. Literal interpretations may reinforce culturally imposed limitations to our thinking such as conflict generated by the presumption of dichotomous relationships which blinds us to the possibilities of alternative explanations (Lakoff and Johnson, 1980, 223). Instead of assuming the possibility of only right or wrong answers, binary pairings, or polarised argument, it is often more productive to consider what may lie hidden from us in the structures of such conflicts. Therefore metaphorical analysis may assist us to discern '...by implication, further facts of which were not aware until we analysed our assertion...' (Langer, op. cit., 114). In this study metaphors will be used to analyse known facts and draw inferences from them to assist in developing a pedagogy in a relatively new area of teaching: design education.

In its conventional form, design education's conceptual and physical manifestations have proved difficult to understand, and as will be shown below, sometimes approaches incoherency. An alternative approach is required to discern meaning from the conventional representation of design education, an approach which allows sufficient freedom for teachers to apply experiential contexts to the phenomenon; one which will allow for reflection and insight leading to the development of a repertoire of coherent operational strategies; a pedagogy. As tools for thinking, metaphors allow us to structure our concepts, to understand and experience one kind of thing or action in terms of another (Lakoff and Johnson, op. cit., 5). For teachers, metaphors offer an opportunity to '...structure our understanding of the process of teaching and learning ...' (Tiberius, 1986, 144).

This study will examine the nature of design education, its history, its character, and its conventional pedagogy. This pedagogy will be analysed metaphorically, and from there move towards a synthesis of an alternative pedagogy based on practitioner experience. Consequently, the study will be practitioner-oriented, that is, it will draw upon anecdote and case study, supported by the professional literature, narrative description, and analysis of my experiences in the implementation of design education in the classroom.

Accordingly, in its practitioner-orientation, this study will take account of me as a '...thinking, deliberative...[agent]...oriented towards action...' (Clandinin, 1986, 8), possessing '...personal, practical knowledge...(ibid., 12) of '...the individual case: of what things are and how they work in particular instances...' (ibid., 11).

This knowledge is based on 20 years' experience in six Tasmanian high schools in the Materials, Design and Technology (MDT) curriculum area; comprising three years as a pre-service student; and 17 years as a classroom teacher, including three periods totalling 14 months as an acting senior master of MDT in a large urban high school.

My choice of metaphorical description and analysis based partly on anecdote and case study acknowledges the importance of classroom experience in this study. The context dependent nature of metaphor, that is, its cultural and operational implications, means that '...no metaphor can ever be comprehended or even adequately represented independently of its experiential basis' (Lakoff and Johnson, op. cit., 19). Thus, from my classroom practice I have taken examples of experiential gestalts and attempted to organise them into structured wholes. In other words, in searching for understanding I have used anecdote and narrative as illuminating devices for classroom interactions which are viewed as multidimensional entities having specific properties. Consideration of these gestalts then allows for identification of significant aspects of the experience which in turn becomes the framework for new understanding: 'structuring our experience in terms of such multidimensional gestalts is what makes our experience coherent' (ibid., 81). Such coherency allows the development of an alternative design education pedagogy based on that new understanding.

The emphasis on design education in the MDT syllabuses for the new Tasmanian Certificate of Education has led to a need to redefine the purposes and processes involved in its teaching. This reappraisal of pedagogy in conformity with the design education concept is not limited to MDT, but also has implications for other curriculum areas where students work with materials, tools, and machines, such as *Art, Home Economics,* and *Science..* Indeed, some argue that the problem-solving orientation of design education should permeate all aspects of the curriculum; it should be a universally adopted pedagogy (Baynes, 1982, 5-11). Whilst recognising the comprehensive nature of design education's usefulness and its broader applications, this study focuses on MDT and is further narrowed to consideration of one subject within that curriculum area, *Design in Metal.*

Design in Metal is a group of three neighbouring 100 hour syllabuses for grades 9 and/or 10, and in most secondary schools its 100 hours of instruction takes one academic year to complete. It replaces the School Certificate two year syllabuses in *Metalwork* for grades 9 and 10. The new syllabuses originated in the introduction of the Tasmanian Certificate of Education (TCE) which replaced the School Certificate in 1991 and will replace the Higher School Certificate by 1993. The TCE itself represents an intention to restructure secondary education in Tasmania in accordance with the policy document *Secondary Education: The Future* (Tasmania, 1987).

Secondary Education: The Future drew its information, conclusions, and prescriptions from a wide range of sources dating back to the Scott Report on secondary education in Tasmania (Tasmania, 1977), and included input from students, teachers, parents and community groups, as well as recent reports on secondary education from other states and from other countries. *Secondary Education: The Future* seeks to address the various demands being made on secondary schools by the rapidly changing social and technological milieu in which they operate. To this end, it prescribes, more closely than before, *what* should be taught in secondary schools and *how* it should be taught. For example it identifies '...important fields of knowledge...' (ibid., 12), and requires that they should be taught in secondary schools. Furthermore it instructs teachers to purposefully and deliberately develop certain student competencies and characteristics including knowledge and skills associated with

> Working creatively and solving problems. This includes the ability to use ideas and materials inventively - recombining ideas to meet new situations and contexts, and extrapolating beyond what has been given explicitly (ibid., 17-18).

The TCE and its syllabuses are intended to address the requirements of *Secondary Education: The Future,* and thus through courses of study derived from them the policies so enunciated will be implemented in the schools and classrooms of the state. This study will focus on my experience in implementing design education in the new TCE subject *Design in Metal* which is, in part, based on my earlier experience in teaching to a design orientation in *Metalwork* in the former School Certificate syllabuses .

Design was an integral part of two of the former two-year syllabuses in *Metalwork:* levels II and III, and was expressed in terms of students completing projects '...with a view to stimulating initiative, and creativity and to developing problem solving skills' (Tasmania 1986, 115). Level III students were identified as those who amongst other things, '...present plans of their work and show an understanding of the processes in involved in completing a project...' (ibid., 22). Students at the lowest level of achievement, level I, were not required to present any evidence of their engagement in the work beyond actually making something.

Notwithstanding these provisions for design involvement, students studying these courses could be, and were, presented for levels II and III awards with minimal design component in their courses of study. This arose because of individual teachers' interpretation of the syllabuses in extracting meaning from the design requirements which were embedded in a wide range of other requirements such as self-reliance and initiative (ibid.), and in students' demonstration of '...a greater depth of understanding and...special skill in the subject' (ibid., 115), without prescriptions as to their weight in the overall course pattern. Thus some teachers (myself included) developed courses of study which placed relatively little weight on the design requirements and used other means of establishing levels of attainment in the nebulous qualities of self-reliance, initiative, understanding, and skill in satisfying the requirements for making an award. In my case courses tended to emphasize excellence in workmanship (Pye, 1971, 13-24) through mastery of relevant tool skills. Tool skills in the context of this study means skills associated with all relevant tools, materials, technologies, and processes necessary for making an artefact. Mostly, assessment instruments took the form of normatively derived objective and/or subjective judgements based on students' levels of motivation and involvement. Discussions at regional moderation meetings in 1981, 1983, and 1988 confirmed that many other teachers followed a similar procedure (personal knowledge). In fact, in 1984 my similarly structured course of study for *Woodwork* was adopted as an exemplary course of study by the Region 4 Moderation Committee (ibid.). Therefore, I believed that my interpretations agreed with common practice in the subject.

The prescriptions of the new *Design in Metal* syllabus are such that courses of study derived from it allow no such liberal interpretation. For example, the design intention is now more firmly stated in all three of its syllabuses, namely *9/10 MD204 B Design in Metal - Stage 1; 9/10 MD205 B Design in Metal Stage 1; and 10 MD406 B Design in Metal Stage 2.* This marks a departure from the former *Metalwork* syllabuses in which design requirements were included in the upper two levels of achievement only. The design intention is expressed in each syllabus in terms of learning objectives, knowledge content, and skills content (Tasmania, 1991), but for teachers and students design reaches its most crucial expression in three of the twelve equally weighted criteria for assessment.

For teachers, these assessment criteria present a requirement to invent learning situations which will allow them to be addressed, despite now having half the time available (one year instead of two) and at the same time creating designing opportunities for *all* students instead of just those from the upper ability levels. Specifically the design requirements of the syllabuses in *Design in Metal* are:

9/10 MD 204 Design in Metal - Stage 1...

6. demonstrates communication through presenting simple graphics of work undertaken...

7. demonstrates a basic understanding of design principles...

8. works through the design process to solve problems, judging the value of their own [students] work and the work of others...(ibid., 3).

9/10 MD 205 B Design in Metal - Stage 1...

6. demonstrates commitment through producing and presenting reports and graphics of work undertaken...

7. demonstrates how the design principles are applied to consumer goods...

8. demonstrates an understanding of the design process in the workshop through the production of work undertaken and can appreciate why the process is a way to solve problems...(ibid., 3).

10 MD 406 B Design in Metal - Stage 2...

6. demonstrates communication through providing and presenting complex folios and graphics of work undertaken...

7. demonstrates an appreciation of the role of design to specific limitations...

8. applies the design process in the development of student-initiated tasks...(ibid., 3)

Together, these three criteria represent one quarter of the assessment to be addressed in each syllabus. No other single element dominates the assessment criteria to the same extent as does design. Therefore it seems essential to establish a pedagogy which will address the syllabuses' design education requirements in the context of time and student limitations outlined above. To establish such a pedagogy, an understanding of the conventional meaning of design and its associated forms like design process, design principles, and design education, is necessary in attempting to formulate a coherent pedagogy.

A literal definition of design is a good starting point, although as stated above and explained below, it has led to a dearth of coherent operational teaching strategies. Two definitions of design are:

> design v.t. to make working drawings for; to contrive; to intend; a working drawing; a plan or scheme formed in the mind; intention; relation to parts of the whole, disposition of forms and colors; pattern...(Webster's, 1990)

> design v.t. to prepare the preliminary sketch or the plans for (a work to be executed) esp. to form the plan or structure of: *to design a new bridge.* 2. to plan and fashion artistically or skillfully. 3. to intend for a definite purpose: *a scholarship designed for medical students.* 4. to form or conceive in the mind; contrive; plan. 5. to mark out, as by a sign; indicate... (Random House 1968,360).

From these dictionary definitions the operational components of design appear to be intention; conception; planning; and contrivance. Moreover, both definitions acknowledge the idea of expressing and organising design ideas through the medium of drawing in either a preliminary sketch or working drawing. The second also takes the idea to a further, more concrete expression of design as one of fashioning artistically or skilfully; to make or adapt the idea into reality. Thus from these definitions design emerges as a process oriented activity involving four stages: conception; drawing; planning; and making; where the production of a working drawing includes development of ideas formed in the conception stage.

Those who apply these processes, designers, operate in all fields of human endeavour where people are faced with problems arising from the man/environment interface, their purpose being defined as '...finding the optimum in a particular set of circumstances' (Hanks and Belliston, 1978, 36). These "particular circumstances" define the design context, and it, in turn, leads to the application of certain universal design principles. Mayall lists these principles as being the technical; the ergonomic; and the aesthetic; and their integration into a design solution will be '...limited by the materials, tools and skills at his [the designer's] disposal' (Mayall, 1967, 11). These limitations form the designer's '...framework with which he creates his product' (ibid.). Thus designers operate both in a design context and a design framework, but translating these elements into some form of coherent instructional action in the classroom has proved difficult.

Teaching design is quite different to the actual act of designing, and confusion as to the degree of similarity between them has contributed to considerable debate and unease about design activities in MDT. In MDT, just as in some other areas of teaching, there is sometimes held the belief that '...teaching is...a mirror image of learning' (Brady, op. cit., 4). That this is not so will be shown below. From this assertion will emerge a demonstrated need to develop a coherent operational definition for design education based on its teaching, not its learning.

Maldonado claims that '...education for design is education for responsible creativity' (1965, 122). In saying this Maldonado recognises four modes of design: its creative aspect; its conceptual state; the fact that it takes place responsibly; and that it is represented by a constructive act, not merely a declamatory act which occurs when the designer is only able to declaim or criticise without offering or attempting to accept responsibility for a new concept. Essentially, designing is a creative act, says Maldonado, and the designing act is linked to cultural and social contexts, leading to the conclusion that '...education for design cannot be indifferent neither socially nor culturally...'(ibid.).

Green underscores the social responsibility of designers when he points out that design education is '...not about good taste or buying wisely...[but is]...more concerned with developing a critical understanding of human needs and gaining experience in evaluating whether these needs have been met adequately' (1978, 7). He sees that design decisions are related to the problem solving process, that is '...the basic process of identifying a problem or need and then testing a solution'(ibid.).

Green's definition of design education links it to problem solving; a link which has been instrumental in the development of the conventional pedagogy for design education. It also teases out

Maldonado's ideas of design being related to responsible creativity; the creation of a solution within a social and cultural context, but more importantly it recognises its developmental and experiential aspects. Furthermore, his addition of a fifth stage, testing, recognises the evaluative function of the design process.

Thus, the conventional pedagogy for design education is process oriented, it is a process which allows an individual to proceed step by step in a linear fashion from *conception* to *drawing* to *planning* to *making* to *evaluation*. The design process is characterised as problem-solving through a series of temporally related stages starting with the identification of a problem and proceeding via a diagnosis of needs, conception of solutions, implementation, and evaluation, moving towards an optimum answer which satisfies the criteria set up at the beginning (Eggleston, 1976, 17). Figure 1 depicts the concept graphically.

CONCEPTION DRAWING PLANNING MAKING EVALUATION

FIGURE 1: **THE DESIGN PROCESS**

The concept of design as a linear process has, in some cases, led to a presumption that its literal interpretation is its only form of expression; that the concept being modelled is the model itself. Indeed, a caricature of the design process simplifies it to that of the designer acting as

> ...a human computer, a person who operates only on the information that is fed to him and who follows through a planned sequence of analytical, synthetic, and evaluative

> steps and cycles until he recognises the best of all possible solutions (Jones, cited by Eggleston, 1976, 18).

Simultaneously, however, design has certain subjective and cultural aspects (Maldonado, op. cit., 122). It is basically creative, but its creativity is tempered by a recognition that it carries constructive and social responsibilities. Yet this dichotomy between the objective and subjective nature of the design process obscures the interrelationships between both aspects. For example, each of the stages in the design process themselves will be microcosms of the subjective, creative and social aspects referred to. However, irrespective of the particular interpretation of the nature of design it will still conform to the universal design principles mentioned above (Mayall, op. cit., 11), but with varying degrees of emphasis on each depending on the design intention.

Although these interpretations and analyses of design, design principles, and design education have assisted in establishing some'...facts of which we were not aware...' (Langer, op. cit., 114), and upon which some design pedagogy has been based, the expression of design education so derived is pedagogically embryonic; it is not yet a coherently stated operational teaching strategy as will be shown below. To place this study in its proper context it is necessary to look at when and how design education has appeared in curriculum areas akin to MDT in schools both internationally and nationally, and to study the experience, if any, in developing a pedagogy for design education.

CHAPTER TWO

THE EVOLUTION OF DESIGN EDUCATION IN MATERIALS, DESIGN AND TECHNOLOGY

Design education has been represented in school curriculum areas like MDT, that is, subjects which engage students with materials, tools, and machines, for 100 years, although its emphasis relative to other, presumably competing, aims in the subjects such as tool skill development has waxed and waned. Education with materials, tools, and machines has evolved in Western schools to establish a place for itself in secondary education, albeit a place sometimes criticised and sometimes challenged as to its intellectual value in the curriculum.

As well as MDT, the present-day names applied to this curriculum area range from *Technical Studies, Manual Arts, Industrial Arts,* and *Technology and Design Education* in Australia, *Design and Technology* in New Zealand, to *Industrial Arts, Technology* , and *Technology Education* in North America, *Craft, Design, and Technology* and latterly *Design and Technology* in England and Wales, and *Technical Education* and *Technology* in Europe.

Almost all trace their origins to the Swedish Sloyd of the nineteenth century; a subject which used woodwork as a heuristic method of teaching. The claimed values of this approach to learning were manifold, among them ideas that such school work would:

> ...give a taste of rough labour as distinguished from clerkly accomplishments...[cultivate]...manual dexterity, self-reliance,

> accuracy, carefulness, patience, perseverance, and especially ...train the faculty of attention and develop the powers of concentration (Dodd, 1983, 19-20).

By the beginning of the twentieth century schools on both sides of the Atlantic had taken up the idea. In North America *manual training* was introduced in 1886 essentially as a part of liberal education in schools in Saint Louis, Missouri. Its intention was to enable students to understand and deal with the world about them (Deighton, 1971, 33). Its beginnings in liberal education were lost, however, as the subject idea spread to other schools where it soon assumed the practice of graded manual exercises, most commonly in wood, aimed at developing tool skills (ibid.). At about the same time in England, *manual training* was also introduced, and even though the same holistic values were ascribed it as the Saint Louis initiative, its practice quickly focused on training in practical skills in their own right since most pupils were thought likely to become artisans (Blishen, 1970, 333). It was the persistence of this emphasis on tool skill development and an orientation towards pre-vocational training which contributed to the criticisms and challenges about its legitimacy as a school subject.

In England particularly, the social implications of lower class activities being characterised by manual work and the apprenticeship system; and upper class activities by academic endeavour and the scholastic tradition of the grammar schools, led to '...crafts, technical studies and practical activities...[being]... regarded as low status subjects because of the vocational and hence, social status they conferred' (Dodd, op. cit., 16).

These shortcomings were anticipated by pioneers in the field such as Woodward in Missouri (Deighton, op. cit., 33) and Barter in England (Blishen, op. cit., 333; Dodd, op. cit., 21-23), but their heuristic ideas about craft study leading to intellectual development were unable to prevent the subject's interpretation as a tool skill process aimed at pre-vocational training. Even now the pedagogical debate is polarised and, as will be shown below, its polarisation is based on the conflict arising from the assumed dichotomy between tool skills development and intellectual development; dichotomous, that is, in the presumption that there can be no intellectual content in the tool skills orientation, and that tool skills mastery cannot be taught concurrently in the design orientation.

In searching for a heuristic base and consequent legitimacy for the subject, several avenues have been explored, including ascribing to the subject intrinsic educational values such as the development of '...good character, a sense of responsibility, self-reliance, initiative, self-respect, willingness to co-operate, good citizenship, aesthetic sensitivity, and a "right attitude" to work' (ibid.), or making the study one of '..interpreting the material culture, or technology' (Deighton, op. cit., 31). Most have resulted in some reform, but generally speaking over the last half century or so, as exemplified by classroom practice, progress towards an intellectual foundation in the subject has been virtually at a standstill, despite the efforts of educationists on both sides of the Atlantic. In fact, it could be fairly claimed that research and innovation in that period has proceeded at a pace which has defied implementation in the classroom. Twenty years ago Deighton observed that:

> Through the years, the leadership of industrial arts has reached further than the classroom teacher could grasp; at the classroom level the typical industrial arts program still consists of woodwork, mechanical drawing, and metalwork, not measuring up even to the program recommended by the profession in the 1940's (1971, 35).

Arguably the situation has been similar in New Zealand and Australia, hence the current efforts to increase the intellectual demands on Tasmanian students in MDT through the syllabus prescriptions detailed above. Notwithstanding the currency of some of the intrinsic values mentioned, a problem-solving process and its extrapolation to the design process has been the most singularly pursued mode of reform. This is not to say that problem-solving or design are new concepts in MDT and kindred subjects. In England in 1892 the broad aims of manual instruction were said, amongst other things, to be the '...development of the manual and artistic activities of the child...to awaken and train the artistic faculties...to provide opportunity for the development and practice of the inventive and constructive faculties...' (Dodd, op. cit., 22-23), but it was interpreted in the context of an emphasis on the acquisition of technical skill and little was achieved in terms of the artistic or inventive elements of design. When, however, in 1910, a freer, more student-centred approach was advocated in the interests of intellectual development the presumed dichotomy between tool skills development and intellectual development led to design being interpreted as so student-centred as to present itself almost as a caricature of discovery learning which '...gave way, in many cases, to a situation in which the child was given no help or guidance whatsoever' (ibid., 24), and was simply left to his or her own devices. Little had changed when, half a century later, the same uncontrolled approach was still being applied, and Kimbell reported Bantock's findings of 1968 when he observed a class subject to little formal direction in applying the design concept:

> They wanted to make a submarine the teacher will say indulgently, indicating a chaos of bricks and an apathy of constructional effort. They're exploring materials she will add, pointing to a witches brew of old cereal packets, matchboxes and goy. All too often what these children are doing is thrashing around in a void, unhindered and unhelped by anyone who really knows about the constructional possibilities of bricks and other materials (Kimbell, 1982, 50).

Interpretation of the meaning of design in terms of its dichotomous relationship between tool skills development and intellectual development was, and still is, a major stumbling-block to progress.

Design was mentioned in the Ohio plan of 1934 when it was listed as one of the subjects included in industrial arts, namely '...drawing and design, metalwork, woodwork, textiles, printing, ceramics, automotives, foods, and electricity' (Deighton, op. cit., 34). Its use here placed it in its usual industrial context; an activity which is closely allied to drawing but usually separate from the manufacturing process (Heskett, 1980, 10). Thus this expression of design cannot be construed as a problem-solving approach. In North America, it was not until 1952 that Maley began to formulate a coherent pedagogy incorporating a problem-solving approach to industrial arts embracing some elements of design.

Maley 's work centred on schools in Maryland, and between 1952 and 1959 his idea was developed and implemented in those schools. Maley identified two basic principles for teaching in industrial arts:

> ...first, the idea that mastery of problem-solving skills is is a more worthy educational goal than the mastery of manipulative skills; and second, the idea that the principal function of education, including industrial arts, is the development of people rather than things (Deighton, op. cit., 16).

However, the application of the Maryland plan in the classroom required a degree of student initiative approaching that hoped for in the 1910 situation in England. The freedom afforded students was such that it was found to work best '...for students who are curious and who thrive on analyzing problems and the challenge of a research-type environment' (Deighton, 1971, 17). Students were expected to contribute ideas through seminars which would enable them to '...crystallize and refine' (ibid., 16) their assigned problems after which research and experimentation could take place in an industrial arts laboratory. There was no place in the Maryland plan for '...teacher-designed or prescribed experiments' (ibid., 17).

Meanwhile, recognition that all was not well in the craft area in English schools was evident. In 1920 manual instruction was renamed *constructional handicraft,* '...so named no doubt, to emphasise its reliance on the two aspects of designing and making' (Dodd, op. cit., 25). In 1927 the Board of Education advocated the following aims for constructional handicraft: '...the development of initiative and self-reliance through designing and making in the workshop, and the acquisition of good taste through a desirable integration with Art' (ibid., 26).

By the post World War II period the subject had evolved into *handicraft,* or *craft (woodwork and metalwork)* (Glenister, 1968), and its assumption of a low-status subject was confirmed. The Crowther Report of 1959 encouraged the view of handicraft as the 'alternative road' for those students who had lost '...their intellectual curiosity before they had exhausted their capacity to learn...' (Dodd, op. cit., 27), although it did recommend that those students should face increasingly intellectual challenges within the subject itself.

In the schools the low status of handicraft was not necessarily negative, as there was recognition of handicraft teachers' '...ability to communicate non-verbally by being increasingly provided with more time with more difficult and less articulate secondary students...' (Eggleston, 1976, 8-9). Was this a backhanded compliment? Was handicraft merely a convenient dumping-ground for these students? Whether it was or not, the fact remained that there was a

> ...widespread belief in the low intellectual content of the practical subjects and the lifestyle of those who practised them... [destining]... them inescapably to a low status in the curriculum of virtually every school...'(ibid., 6).

Several research projects through the sixties and seventies such as *Project Technology* (1967 - 72), *Design and Craft Education* (1968 - 73), *Design Education Research* (1973 - 5) *Art and Craft Education* (1969 - 72) and *Arts and the Adolescent* (1968 - 72) sought to redress the situation and provide impetus for the orientation to be focused on design education in handicraft subjects (Eggleston, op. cit., 14). Design education was seen to be the answer to increasing the intellectual demands made of students, and would, at the same time, encourage '...a genuine fusion of intellectual and and practical activities' (ibid.).

Design education would bridge the gap between the tool skills orientation and the intellectual orientation in handicraft which had hitherto been regarded as mutually exclusive domains. Allied to the factors of intellectual rigour and status was the awareness that society and the nature of industry was rapidly changing. Production of wood and metal objects by hand was declining rapidly in real-world industry and this was seen to be stripping away legitimacy for the subject based on a real-world interpretation of technology and industry. The speed of knowledge accumulation and technological change was such that other curriculum areas also recognised the need for a different approach to education. No longer would the passive receipt and subsequent regurgitation of facts be assumed sufficient to educate students. The curriculum began to assume a form that '...emphasised adaptability, originality and participation rather than memory, stored knowledge and passivity' (ibid., 11). Design education was seen to be the best approach for crafts in addressing these manifold requirements.

Paradoxically, the real-world claims for design education's legitimacy are flawed in exactly the same way as is its legitimacy based on producing wood and metal artefacts by hand. It must be remembered that in its designer/maker interpretation design education has no contemporary real-world counterpart. The concept of design being applied to school education as a real-world phenomenon is just as contrived as the making of wood and metal artefacts by hand because the real-world processes of creation, invention and definition are separated from the manufacturing processes, and have been since the restructuring of industry arising from the industrial revolution 200 years ago (Heskett, op. cit., 10). Thus the casting of students in the designer/maker role derives its real-world legitimacy from the medieval craftsman's work of a pre-industrialised context which was characterised by '...a high level of skill and artistry...[in which]...the boundaries between artist and craftsman were fluid...' (ibid., 11).

Although implied in the 1927 English Board of Education's endorsement of '...designing and making...' (Dodd, op. cit., 26), the creation of the student designer/maker seems to originate in the publication of a pamphlet *Metalwork in the Secondary School* in 1952 which envisaged educational benefit in its study would accrue from

> '...discussion, planning, solving problems, tackling difficult tasks and the realisation of the end product. Thus was "making" put into the sequence of the "design line" and equated with other stages in the process' (ibid., 27).

Nevertheless, the designer/maker role is seen by many as the preferred mode of instruction in design education. Kimbell, for example, believes that: 'Designing without the requirement of making invites shallow responses...' (1982, 48). Yet, some contemporary thinkers have recognised this flaw in the present school interpretation of design.

In 1990 Hooper wrote of the difficulty in establishing students' competence in both designing and making and pointed to the English polytechnic strategy of having technicians make up part or whole of a student's design. Such action, Hooper claims, overcomes the school designer's contextual inhibition in that there is no need to

> necessarily start from the basis that here I have a machine which I know is capable of this or that, but from the point of view that here I have an idea which I suspect is commercially viable and is there a way of making it on this machine? (1990, 173).

In saying this, Hooper recognises the limitations the school context places on the creative aspects of design, and he proposes that in schools, just as in polytechnics,

> ...it would be appropriate for a technician to assist in the realisation of a pupil's idea especially in areas where a pupil lacked a particular skill at that moment which would otherwise prevent a good idea being implemented (ibid.).

Hooper's suggestion opens up new horizons on pedagogy in design education. Another adult; a technician, being present in the classroom with the teacher would be of enormous benefit in widening the possibilities for students' design ideas and their realisation. Hitherto such teacher and student assistance has been restricted to a behind the scenes role, with students sometimes having to wait weeks for a particular set of materials to be prepared. A closer relationship within the teaching situation would result in a more responsive and student-centred design context. The operational reality of such a proposal in Tasmanian education's currently straitened circumstances, however, seems remote.

Dissatisfaction with the project oriented tool skills approach to manual arts began to be heard in Australia. In 1971, the supervisor of manual arts for Tasmania, H. J. Cooper, drew manual arts teachers' attention to two articles from the literature; *The project: out or redirected* , and *The future of manual arts and industrial arts* (Tasmania, 1971). Both articles challenged the approaches being taken in teaching in industrial and manual arts, the first in North America, and the second in New South Wales.

The first article argued that a different view was needed of the traditional project orientation upon which all classroom activity was focused. Unless the making of a project became part of a larger process and not an end in itself, industrial arts would be hard-pressed to justify its place in the school curriculum. The concept of the project needed to be expanded to include experiences in problem-solving, planning and design, and searches for relevant supporting information about the project, as well as the traditional experiences involved in making it.

In the second article, its author, Freeth, pointed out that having succeeded in achieving matriculation status for industrial arts in New South Wales, it behove teachers to take a long, hard look at the subject. He saw two broad areas that industrial arts, through the fullness of the whole school curriculum, could contribute to: '...the needs of the individual, and the needs of the community in which the individual lives' (ibid., 8). In turn, the needs for both areas are manifold. For example, the individual requires instruction in content '...which bring[s] the pupil into contact with ideas, principles, and concepts...', the opportunity '...to develop skills in particular areas...[and]...to develop hobbies and interests...' supported by an '...understanding of materials...[entailing]...lessons on the elementary structure of materials' (ibid., 8 - 9).

For the community, Freeth saw industrial arts' role as providing groundwork for future technician and technologist training in place of pre-apprenticeship trade training for the declining numbers of skilled and semi-skilled workers required by industry. Additionally, said Freeth, the community needs '...people with an ability to appreciate good design and with an ability to create and design' (ibid., 10).

Consequently, he said, manual and industrial arts should be used to develop creativity and design sense, but that such development would be

> '...impracticable until the boy has been:
> (a) shown how to use tools and machinery,
> (b) shown various techniques of construction,
> (c) able to appreciate and understand the materials he is to work' (ibid.).

By the early 1980s discussion about design education was becoming a regular feature of the professional literature in Australia. Guy's contribution from New Zealand was typical in its stronger advocacy of the design based approach for manual arts. He saw design in a broad interpretation as

> ... more a way of life with its basic aims concerned with constructive and creative practical work and problem solving - the solving of practical problems using technology (Guy, P.K. 1981, 34).

Guy went on to emphasize the importance of curriculum development and teacher training in the successful implementation of design in secondary schools. His response to critics was, however, somewhat unproductive and churlish, and regrettably is typical of replies by some reformers to their critics and others who fail to embrace their ideas about design education:

> It [design] is not without its critics; knockers; the uninformed and illinformed; or its problems but Design is alive and well in New Zealand (ibid., 35).

Even at the end of the eighties, criticism and questioning of design education still drew negative responses:

> There was much hostility from poorly qualified teachers who found themselves ill-equipped to deal with the new approaches (Hughes, 1989, 5).

G. Hogan, Head Teacher, Industrial Arts, Penrith High School, New South Wales, presumably a well qualified and well informed teacher, was one who articulated his criticism about design education, claiming to reveal the submerged feelings of many teachers about design education being promoted '...as students doing their own thing' (1986, 17), and being at odds with community concern for '...a return to certain classical ideas such as standards, structure, excellence and discipline' (ibid.). Industrial Arts teachers in New South Wales, said Hogan,

> ...did not have an adequate understanding or even a coherent operational point of view, of what was meant by design; nor had they thought out in any systematic way, its role in the education of high school students (ibid.).

Whether or not such a classical age ever existed is not at issue here, but its expression as an alternative to design education highlights the conflicting nature of the debate. Design educators were failing to express, in operationally coherent terms, what their ideas were. Consequently growing feelings of hostility amongst teachers were inevitable as they saw the emerging operational incongruity between the tool skills orientation and the design orientation as it was being expressed by the reformers when they tried to establish a design based approach in the classroom.

Teachers in Tasmania were becoming aware of the increasing emphasis on design in Manual Arts, and its inclusion in its various subjects through the Schools Board of Tasmania was well established, but as pointed out earlier its intention was subject to interpretation and varying degrees of emphasis in courses of study at the classroom level. More discussion began appearing in the literature, much of it originating in England where developments in design education seemed more advanced. Nevertheless, interpretation of design education and its implementation in the classroom was beginning to dominate the reform there as well as here in Tasmania.

In 1982 Baynes' cautionary comments from England on the implementation of design education were reported. He pointed out that implementation was necessarily imprecise and infinite in its forms of expression: it meant different things to different people. Baynes cautioned that design '...is a very new discipline; ...[one]...we...[know]...relatively little about...and that only practical experience in the studio and workshop would reveal what was, and what was not, effective' (Baynes, K. 1982, 5). He went on to say:

> The job which now faces us is to begin to find the answers to teachers and other educationists who ask curriculum questions.Unless we are eventually able to return realistic replies to questions about 'How much?' 'When?' What?' and 'How?'design studies will appear trivial. Arriving at workable answers is not likely to be a speedy process. Perhaps a decade will prove to be a reasonable time scale. But I believe we need, at once, to review the present situation of design in the secondary curriculum and to plan the steps by which something more concrete could emerge in the 1980s (ibid.).

Amongst his recommendations Baynes included the description of a design curriculum '...in terms of teaching methods to be used and the relationships to be encouraged' (ibid., 8), culminating in the articulation of a design pedagogy: '...the study of the principles and practice of education in the design area' (ibid., 9).

Across the Tasman, Guy was attempting the same task; that of formulating a design pedagogy. He saw the first requirement for the teacher was to move away from the roles of director and instructor to those of leader and advisor. He recognised that classroom management in the latter roles was more difficult, acknowledging that:

> '...large classes in practical work can be mentally and physically exhausting and one is prone to take the easy way out: setting projects of limited choice' (Guy, P.K. 1982, 23).

Despite his recognition of some unreasonable demands being made on teachers, Guy further advised them:

> Don't use the bench for formal demonstrations, move around assisting and demonstrating to those concerned. Often something of communal value can be shown to the whole class (ibid.).

Thus for some teachers the very basis of their pedagogy was declared redundant. No longer could they assume correctness in following a tool skills orientation expressed in the completion of students' projects with the overall aim of producing a well-made artefact. Indeed the artefact itself which '...had always been the visible evidence of craftwork...'(Dodd, op. cit., 25) had lost its pre-eminence in the assessment procedure and consequently many teachers '...lost their yardstick of success' (ibid.). No longer would the whole class demonstration, the cornerstone of traditional tool skills teaching (Glenister, op. cit., 111 - 114, Wilber and Pendered, 1973, 224 - 255), be appropriate. These teachers' repertoires of tool skills and associated teaching aids developed over the years were no longer applicable in the classroom in a proactive sense. Instead they were faced with learning new ones such as concreting (Eggleston, op. cit., 25), and/or being able to instantaneously demonstrate those skills they held in reactive situations; classroom situations which unfolded in a relatively uncontrolled manner and allowed little opportunity to gather appropriate instructional aids to hand. For most, the shift of emphasis towards design education required application of a pedagogy which was at best embryonic and, compared to the well-developed traditional tool skills pedagogy it purported to replace, offered little in terms of order and excellence in the classroom.

Notwithstanding their best intentions, the assertions by design education reformers were not being expressed coherently in terms of a pedagogy. Consequently, despite a '...basic convention of language...to utter meaningful, useful, and in the case of assertions, true statements' (Petrie, 1979, 443), design education reformers' exhortations to teachers to adopt the design education concept defied operational interpretation. My own reactions were akin to those reported above; the design based approach seemed worthy of implementation, but it was a difficult task to develop a '..coherent operational point of view...' (Hogan, op. cit., 17). The design education reformers' '...preferred framework for conceptualizing communication...' (Reddy, 1979, 285) failed to match my experiential frame of reference and consequently I was being '...drawn into a very real and serious frame conflict' (ibid.). To illustrate my dilemma, anecdote and narrative below will trace the contemporaneous development of my interpretations and applications of design education in the classroom in the early 1980s; anecdote and narrative which captures '...the juxtaposition of events in time, the "next-next-next" of temporal experience' (Schon, 1979, 278), culminating in the development of a design education pedagogy which was implemented in 1991.

CHAPTER THREE

DESIGN EDUCATION: PRACTITIONER CONFLICT AND REJECTION

In response to increasing professional awareness of the merits of design education I began to develop my pedagogy for it in the early 1980s. Initially, despite its embryonic status, I uncritically accepted the problem-solving interpretation of design education and its linear *construction of conception, drawing, planning, making, and* evaluation depicted in Figure 1 above. The design process was widely perceived thus, and Dodd's declaration is typical of its widespread endorsement:

> The logical sequence of the design-line provides both structure and opportunities for expression, and the solution of design briefs calls for analysis, synthesis and evaluation of a high order (op. cit., 55).

The linear concept of the design process has been perpetuated in its graphical depiction. Liddament points out that the graphical model of the design process '...shows "design" as a *linear progression* from problem to brief, to analysis and investigation, to solution and finally, to evaluation' (1990, 41). Its limitations are recognised, however, and often the linear model is elaborated to include identification of the various cognitive processes such as analysis and synthesis, and convergent and divergent thinking which are required of the designer at various stages in the process (ibid., 45; Eggleston, op. cit., 21; Zanker, 1979, 16). Green adopts a triangular model to express the relationship between the various design stages with bi-directional linking between them, but in all these models the stages are contiguously fixed and the process is linear, even though it may follow a triangular path (Green, op. cit., 13). Paradoxically, Zanker recognises some limitations of the linear model's pedagogic utility when he notes that in regard to the making and evaluating stages, 'too many teachers and students start here' (op. cit., 16).

Dunn appears to approach a more pedagogically suitable model in his circular depiction of the design stages in response to the recognition that design '...is a fluid interdependent process' (op. cit., 18), but his design stages remain contiguously fixed in what is arguably a linear structure, even though its locus is circular. Nevertheless, his provision for two-way circumferential progress between the design stages does break the assumed starting point for the design process at the conception stage and completion at the evaluation stage. Despite this promising departure from the conventional design process model, Dunn then goes on to advise the reader that 'the rest of this book shows design as a linear process for convenience' (ibid.) and he assumes the typical straight line model described above.

Some authors depict the design process as a comic strip or a series of cartooned characters in a story-telling format (Eggleston, op. cit., 40-41, 74-76; Toft, 1987, 9), but whatever the mode of presentation the underlying structure of the design process is linear. Liddament observes that the linear construction of the design process model is '...fairly typical of the way in which design, as a problem solving activity is presented in many currently popular textbooks on designing in the CDT [Craft, Design and Technology] context' (1990, 40).

Thus, the conventional design process model implies a left-to-right, top-to-bottom, beginning-to-end interpretation and application, although as implied by Green and Dunn and stated by Liddament, it may be further refined to include a certain '...corrective factor...' (ibid., 41) which may be required as events unfold; there my be a need to act retrospectively at the drawing stage, for example, return to the conception stage in the light of difficulties encountered in drawing the idea or perhaps at evaluation the solution may be discarded and a return made to the conception stage. In Dunn's model, activity may well start at an intermediate position in the model, but progress from there is limited to contiguous design stages. The reactive element is illustrated in Figure 2 which is a generalised depiction of the design processes discussed above. Expressed thus, the design process presents itself as a linear cycle.

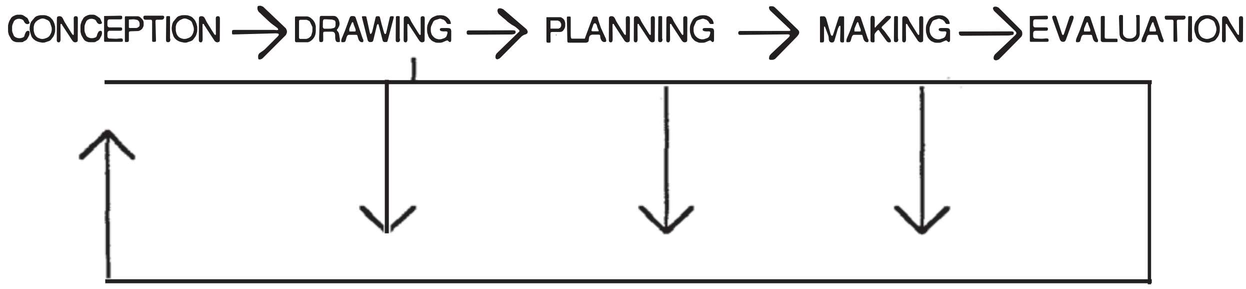


FIGURE 2: **THE REACTIVELY LINKED DESIGN CYCLE**

Despite the superficial clarity of this model, my practical application of the linear design concept in the classroom led to many students being stalled at the conception or drawing stages, or otherwise making unrealistic decisions in those stages which subsequently hindered their progress in other stages. Few were able to proceed through the activity in a rightwards direction from beginning to end. Consequently, faced with either idle students unable to make their decisions or makers hopelessly overwhelmed by the sophistication of their ill-conceived designs, the immediacy of the situation led me to initiate action and control outcomes by suggesting ideas through encouraging students to select from a range of ideas and drawings I supplied. Thus the conception/planning/investigation stages were sometimes verbal and did not reach a documentation stage for many of my students. Apparently this was a mistake, because as Kimbell says:

> Establishing a tradition where ideas and thoughts are not discussed until they are down on paper will go a long way to towards achieving progress, for once it is down on paper children all too readily recognise their shortcomings and are open to guidance in improving their efforts (op. cit., 45).

Consequently, with little formal expression of students' ideas, I had to find time each lesson to speak to some students about their intentions. Fortunately groups were relatively small at 15 to 18 students, but nevertheless I began to feel the increased workload arising from the cumulative effect of having to verbally monitor various project intentions. As well as my increased workload within the classroom, my lesson preparation was extended to ordering supplies of various kinds of materials for students' projects and simultaneously I had to carefully judge whether students' design solutions matched their tool skills mastery.

In keeping with existing school subject department policy, the design project was regarded as the culmination of students' four years' study of the subject; it was a major project, thus the time made available was usually all of second and third terms. Items made ranged from G-clamps to vices; garden forks to wheelbarrows; a representative selection of tools and equipment usually found in students' homes.

Processes and skills required included marking off, cutting, filing, producing screw threads, welding, forging, heat treatment of high carbon steels, machining with the lathe and shaper, and sheetmetalwork forming and joining.

As recommended by Guy (1982, 23), I didn't use the bench for demonstrations, but moved around the room helping where appropriate. Not only was this course adopted because of Guy's ideas, but the diversity of work being carried out made the formal, whole-group demonstration redundant. Consequently individual or small group demonstrations were used to help students, and often required the use of students' work to demonstrate a point which in too many cases ignored advice that:

> *Only in a case where the project is likely to be spoiled, or where the student's self-confidence and sense of achievement are endangered, is the instructor justified in taking the work temporarily into his own hands* (Wilber and Pendered, op. cit., 227).

This approach, with its presumed tool skills mastery, but typically requiring instruction, revision and reinforcement of previous tool skills instruction simultaneously with the design realisation phase, led to undue repetition of teaching and made unreasonable demands on my time and energy. The wide-ranging nature of the individual design realisation activities eroded my ability to temporally sequence the overall workshop undertaking, causing bottle-necking at scarce but essential tools and equipment and delays in availability of necessary materials. At times it must have looked as if the students were '..thrashing around in a void, unhindered or unhelped by anyone who really [knew] the constructional possibilities...' (Kimbell, op. cit., 50) in metal. Much material was wasted, and students became increasingly restless and troublesome as they waited for me to teach them the tool skills necessary for the next step of their work or waited for their turn on the solitary bench drill, shaper, or welding machine. Many became bored and turned to unruly behaviour as an escape, taking advantage of my preoccupation in tutoring students in necessary tool skills, thus jeopardising the safe working environment. Towards the end of the year there was a frantic rush to finish the work, often necessitating lunchtime and after school sessions. Nevertheless, storerooms were left cluttered with unfinished or unwanted projects, the sorting and salvaging of which further added to my workload. Upon reflection I began to question the validity of the design-oriented approach in the reality of its teaching context. It may have worked for others, but I could see little prospect of the same happening for me in its conventional interpretation.

In my first analysis of the problem, I saw that I was focusing on metal as the teaching/learning medium without having established sufficient learner mastery in it. Who, I asked myself, would expect students to learn from and by the written language if they had insufficient mastery in it, that is they could not read or write the language. Despite exhortations that '...skills and knowledge should be acquired "on the way"... ' (Weston, 1990, 32), it seemed that this approach was '...akin to someone trying to use a typewriter or a word processor without a knowledge of spellings or grammar' (West, 1990, 39). Yet this was what I was attempting: students who lacked mastery of the medium of instruction were expected to express themselves in it. As well, I was failing to heed the findings of contemporary educational psychology about setting students short-term goals in preference to long-term. Major projects of two terms' duration proved too long for some students' levels of motivation, especially when they were making an artefact they had not seen before, because its '...path to achievement...' (Cronbach, 1977, 597) was less visible than that associated with tangible nature of the tool skills oriented project.

Moreover, I had allowed the assumptions underlying the tool skills based approach to influence my pedagogy in the design based approach. Because relatively complex projects had been made using the tool skills development orientation, I assumed that the same level of sophistication would apply in the design orientation. I had failed to recognise that with the new approach '...the project [would] become smaller' (Tasmania, 1971, 2), or that perhaps '...a project may have no take-home product resulting from the completed activity' (ibid.).

At the time, the problem seemed resolvable by splitting the two processes of skills development and design realisation more definitively but retaining complementarity in the overall instructional context. More disciplined and purposeful skills development based on shorter-term goals should precede appropriate design realisation; appropriate in the sense that there would be a matching of the skills learned with the skills expected to be exercised. In fact, students would be:

> (a) shown how to use tools and machinery,
> (b) shown various techniques of construction,
> (c) able to appreciate and understand the materials...[they were]...to work (Tasmania, 1971, 10).

Accordingly, I restructured my course in the following years with a much greater component of tool skills development and left the relatively lightly weighted design phase for those who progressed fastest in the tool skills acquisition phase. Tool skills development focused on projects I had conceived, drawn, and planned; concentrating student activity in the making stage in terms of the design line; a course which many had condemned as intellectually barren. But this approach did not necessarily lack cognitive challenges simply because it did not follow a design orientation. Arguably, students' thinking was facilitated through language interaction; language interaction of the kind Vygotsky calls non-verbal thought; thought which extends by formal and informal language to verbal thought (Britton, 1970, 203-206).

In the tool skills development approach, teaching through common projects exposed students to language in all its forms: listening; talking; reading; and writing. Because of the common nature of the learning tasks, language interaction between students became focused on those tasks. They were expected to work with symbols in reading my working drawings and to develop increasingly abstract understandings in scale and analogue models I had made as instructional aids (Black, 1962, 222-223). These controlled activities were not intended as ends in themselves, but rather, as

> ...practical activities...which...lead first to 'collections', the grouping of different objects that complement each other in some particular form of tool-using activity: and such functional collections pave the way for functional groupings in which the criterion, ' I can use that for...' becomes the more abstract basis for a more theoretical category. The operation of such a principle leads in turn to the ability to form fully abstract categories, categories capable of dividing phenomena

> into the 'x' and 'not x' at successive stages of generality and so permitting the pursuit of what Piaget has called 'the consideration of possibilities' (Britton, op. cit., 213).

But design education purists would regard this pedagogy as reactionary; a retreat to the comfortable and familiar, yielding to the temptation to take the '...easy way out: setting projects of limited choice' (Guy, 1982, 23). Nevertheless, the contemporaneous interpretation of design in my course of study was in accord with its embedded and nebulous expression in the Schools Board Manual for the subject. But the new TCE syllabuses for *Design in Metal* have removed my professional freedom to design my courses of study to fit their teaching contexts. In terms of these syllabuses my courses of study and my pedagogy are redundant.

Why would I, as a teacher, acting in my students' best interests and practising a 'moral craft ' (Tom, 1984) find difficulty in accepting this? Was I confirming the assertion that '...teachers are lax...'? (Tasmania, 1971, 3). Was I choosing to '...neglect design and research'? (ibid.). Why, I asked myself, '...is the theory on a higher conceptual plane and the practice at a lower level?' (Booth, B. 1990, 46). Despite the lessons of history were research and innovation in design education proceeding at a pace which defied implementation in the classroom?

In examining these two experiential gestalts, these structured wholes of pedagogical experience of my teaching to a design orientation or for tool skills acquisition, some understanding of the influences at work in them began to emerge. It seemed to me that all too frequently the alternatives to the traditional skills acquisition teaching approach were presented as bipolar opposites: problem or no problem; control or no control; teacher-centred or student-centred. For me, an approach to teaching based on a problem-oriented, teacher-centred approach with diminished control over content had led to a situation of disorder bordering on anarchy; the anarchic classroom being characterised by unrealistic demands and expectations by students for instantaneous individual and personal attention which stripped away the initiative I formerly held. The *what, when* and *how* of my instruction became unreasonably held in the hands of the students and my teaching, despite its original aims of openness, became more closed than the traditional approach as the teacher-centred, reactive mode of practice took hold. It was arguably less beneficial for all concerned as I attempted to spread myself thinly over the classroom landscape. I felt that this approach made '...inordinate demands on...[my]...time and ability...[that it required]...a fantastic range of knowledge and skills...(along with) extraordinary feats of pedagogical ingenuity' (Stenhouse, cited by Hogan, op. cit., 17). Clearly I needed to develop a pedagogy based on both my experience and the new syllabus. I couldn't change the syllabus, but perhaps by changing my '...concepts and modes of understanding...' (Petrie, op. cit., 440), I could accommodate the prescriptions of the new syllabus in a *sustainable pedagogy;* sustainable in terms of '...the various pressures, constraints and exigencies of everyday life in school' (Dodd, op. cit., 11).

These thoughts were uppermost in my mind, when in first term, 1991, I prepared to teach a grade 9/10 composite group for *Design in Metal* at Rosetta High. In planning the course of study, I started from a contextual point of view. Unlike Hooper, I *did* say to myself '...here I have a machine which I know is capable of this or that...' (op. cit., 173). It seems to me that all pedagogy must be context dependent. The context is here intended in its broadest sense, and includes not only the machines available for teaching, but the full range of benches, tools, materials and other equipment. More importantly, it must take account of the nature of the students being taught, that is their backgrounds in the subject, their stages of physical and cognitive development, their levels of maturity, and even the different times of day the group will meet; morning and/or afternoons. All these factors contribute to the group's design framework (Mayall, op. cit., 11). Moreover, I had not taught any members of the group before, although I knew from teaching some in other subjects and the general conduct of others around the school that I had in the group a large proportion of '...the more difficult and less articulate secondary students...' (Eggleston, op. cit., 8-9), and I had just 100 hours' instructional time to meet the requirements of twelve assessment criteria, three of which were design oriented.

The group was composed of nine grade 9 and ten grade 10 boys. Three of the grade 10 boys had studied the subject in 1990 as a 100 hour course. Some others had had no experience in the subject since grade 8, and some had no experience at all. Nominally, each student was following one of the three neighbouring syllabuses for *Design in Metal,* namely *9/10 MD204 B Design in Metal - Stage 1; 9/10 MD205 B Design in Metal - Stage 1;* or *10 MD406 B Design in Metal - Stage 2,* but at that stage individual students and courses were yet to be matched. In each of the syllabuses was the explicit requirement for me to assess their ability in designing, ranging from '...works through the design process to solve problems judging the value of their own work and the work of others...' (Tasmania, 1991, 3), to '...applies the design process in the development of student-initiated tasks' (Tasmanian, op. cit., 3). Thus the design process and its application to problem-solving was subject to mandatory address, and my responsibility was to create opportunities for that to occur.

I immediately recalled my experiences of the early 1980s described above, when I found teaching to the simultaneous development of tool skills and design education incompatible. I had long since reached the conclusion that: 'the craft skills are an important part of the activity, for those are the enabling skills of the making and doing element of D & T [Design and Technology]' (Weston, op. cit., 32). Quite simply, it seemed to me that if students were to solve problems through the design process then they must be equipped with those enabling skills. This idea had guided my pedagogy through the 1980s and I had ensured that in terms of any students' design activity that 'awareness of an alternative...[would]...be accompanied by the craft knowledge needed to implement this alternative' (Tom, op. cit., 204). More specifically, I wanted students to develop appropriate tools skills knowing, as Dodd points out, that 'questions about which skills, and at what time, are important factors in the teacher's planning if the learning is to be efficient, rewarding, and meaningful' (op. cit., 31).

I have written elsewhere how mastery of these tool skills can be achieved if the teacher facilitates skills learning through a competency-based, student-centred approach such as programmed or mastery learning . Design realisation through mastery learning strategies enables the teacher to retain the initiative and act appropriately in the roles of instructor, manager, and tutor in the design education context (Welch, 1990). Mastery learning, however, does not lend itself to the divergent thinking required for conception in the early stages of the design process (Block, 1971, 66), and consequently ignorance of the necessity for a particular tool skill at the conception stage can lead to insurmountable difficulties at the making stage. Designing through the creative act is '...an act of dissension, in some respects an act of revolt...' and thus, even though it may be the '...result of acquired instrumental skill' (Maldonado, op. cit., 122), the conception of design is not an activity which can be readily brought to students' minds in concrete terms. Therefore, conception for design lacks a clearly identifiable structure, and for many students it is a difficult task to express their ideas in a form which is accessible to others. Lack of design experience also means that their design vocabularies and design languages need to be developed in a structured, purposeful manner (Liddament, 1990, 40). Such expression is important for the teacher because a clear understanding of students' intent is necessary if classroom control in its widest sense is to be maintained, and I had no desire to repeat my earlier mistake in allowing these stages to be dealt with verbally.

Having said that, I am aware that not all student difficulty at these early stages of the design process is necessarily attributable to students' cognitive ability levels. The phenomenon of underachievement, of "playing dumb", is as familiar to me in Tasmanian high schools as it is to Jackson in Californian high schools (Jackson, 1985, 304-305). Nor am I a stranger to '...the distracting and sometimes disruptive behaviour of some less than committed and even psychologically disturbed students...' reported by Hogan in New South Wales (Hogan, op. cit., 19). Nevertheless, in the linear design process, failure by students at the conception stage for what ever reason stalls the whole process; without conception there is no student action, without student action there is no learning, and without learning classroom anarchy begins to take hold.

I knew that some people recommended that initial design problems be kept relatively simple, or even that they be presented in partially solved form. Kimbell endorses this approach when he says '...it is possible to slide back a little from the extreme end [of the problem/non-problem continuum] and leave some of the problem unspecified' (op. cit., 29). Webberley supports this view in his presentation of vices as projects for Technical Drawing and Metal Craft students in grades 10, 11, and 12 where partly completed working drawings are presented with some component design unspecified and left for students to solve (Webberley, 1986). But this strategy fails to address the underlying problem of matching students' stages of cognitive development with the cognitive demands of the task. It confuses quantity with quality, that is the cognitive demands are reduced quantitatively, but qualitatively the need for problem definition, analysis, and collection of relevant data remains no matter how much the magnitude of the task is reduced, and, as Liddament says, these thinking skills '...are all skills fairly well up the learning hierarchy ' (1990, 41). Consequently, students continually experience failure in the initial stages of the conventional design process because their cognitive abilities and teachers' expectations of them are incongruent.

Admittedly Kimbell's and Webberley's approaches stimulate student activity on the non-problem part of the task, but the underlying concept of the design process is still linear in its application to the unsolved problem. In adopting it, the teacher perpetuates the idea that the '...logical sequence of the design-line...' (Dodd, op. cit., 55) can be '...slotted into the pedagogic context without further ado...'(Liddament, 1990, 41). What is ignored is that the "logical" design process is logical for experienced designers, but for teachers and students it '...tends to mask the *conceptual structure* which underpins design activity' (ibid.).

In considering this dilemma, I began to realise that my language and consequently my thinking (Britton, op. cit., 190-218) had imprisoned me in the linear design process and the assumptions underlying it were not allowing me sufficient freedom to develop a pedagogy. Lying hidden in the structure of the conventional view of design as a linear process was a metaphor; a metaphor which was perpetuating this design process model. In my imprisonment I was blinded by the conflict generated by the tool skills development/design orientation and the problem/non-problem dichotomies.

My earlier experiences with design education had pushed and pulled me to and fro; I had adopted *either* a skills development approach *or* a design oriented approach; I was approaching the issue in binary terms when clearly there had to be a closer examination of what influences were blinding my recognition of solutions lying outside this dichotomy. Thus I began to examine the problem itself. I needed to change my perception of the design process by re-setting the problem.

Schon advocates problem setting as being more appropriate than problem solving, particularly in areas where conflicting views such as the dichotomies described above are locked in a non-generative metaphor which offers no solutions (op. cit., 244-256). In keeping with his support for the mediating effects of story telling, I began to narrate what underlying assumptions were impinging on my perception of the problem (ibid., 255).

For all my teaching experience, students had proceeded through their courses of study by completing a number of projects, either teacher-initiated or student-designed or combinations thereof, but connections between each project were quite tenuous; their links were implicit and sometimes invisible to the students. The assumption held was that each project was a separate entity, an episode, and consequently when traits such as perseverance were to be developed it was done by encouraging students to complete their work before moving onto something else; to finish the episode. There was little idea of developing a truly serial character to the course of study. At the time the disparity between the serial and episodic characters of students' projects was hardly recognised, let alone discussed.

Therefore, in structuring a design exercise for *Design in Metal* I initially decided to adopt a two-phase approach which would take the form of making an artefact, an exemplar (Petrie, op. cit., 445-446), as central to the design episode. The exemplar would embody certain design properties and mechanical principles which could be later abstracted to the level of an analogue model of a subsequent design problem. It would be an analogue model in the sense that it relied less upon its original identity but reproduced the structure for a design solution. The analogue model would call for a higher level of abstraction in its conception to a level approaching that of creativity but still retain '...the same structure or pattern of relationships' (Black, op. cit., 223). In doing so, the exemplar would provide a cue for action in developing instrumental skill (Cronbach op. cit., 400), and would be a '...source from which to generate...ideas' (Zanker, op. cit., 43).

By re-setting the problem thus far, I felt that I was beginning to free myself from the culturally imposed limitations of my thinking (Lakoff and Johnson, op. cit., 223). Two artefacts were now replacing one project as the design episode. I was beginning to see the design experience serially, with a number of serial occurrences forming an episode. But more importantly, I was beginning to understand the metaphor underpinning the conventional design process. In its typical linear expression the design process assumed the metaphor that *design is a line;* that is, although the design process was not a line in the literal sense, in its typical application it was assumed to be one. As shown above, however, its linear structure offered limited utility as a pedagogic tool, a fact recognised by Chidgey, who says that 'it is unlikely that "a" or "the design process" exists...' (1990, 44), and then goes on to advocate a search for '...a more flexible framework based on "aspects" of designing, adopted to assist in developing the skills, attitudes and knowledge associated with CDT' (ibid.).

It seemed to me that the best way to resolve the tool skills development/design orientation dichotomy was to seek out a metaphor which could at once incorporate the step-by-step structure of the linear design process and accommodate the conceptual structure needed to incorporate it in a pedagogy. There must be a reason for 'too many students and teachers...' starting at the making and evaluating stage (Zanker, op. cit., 16). Instead of operating in a linear approach, that is design as a line (Dodd, op. cit., 45; Eggleston, op. cit., 23; Toft, op. cit., 9; ibid.), I saw that I had to re-set the problem, and from that re-setting develop a more pedagogically appropriate design process model; one in which the competing pedagogical demands discussed above could be accommodated. Instead of changing my teaching to fit my '...concepts and modes of understanding...' (Petrie, op. cit., 440), I saw that I had to change my '...concepts and modes of understanding to fit...[my]...experience' (ibid).

CHAPTER FOUR

PROBLEM SETTING: ALTERING CONCEPTS AND MODES OF UNDERSTANDING

As I considered the conceptual implications of the conventional linear design process for students, it appeared to me that the inappropriate positioning of the thinking skills identified above, divergent thinking and convergent thinking, relative to their cognitive demands on students at the beginning and ends of the design activity, were at the seat of my unsuccessful attempts to incorporate it as a pedagogy. In the conventional design process '...the logical sequence of operations...[was]...not mirrored by their level of difficulty' (Liddament, 1990, 41).

Divergent thinking involves '...the process of recalling, recognising, or inventing alternative solutions...' (Cronbach, op. cit., 554), while convergent thinking involves '...the process of reducing the array of possibilities until one answer is chosen' (ibid., 555). Perplexingly, their positions in the model relative to the design stages appeared to ignore the teaching maxims of proceeding from the concrete to the abstract, from the specific to the general, of starting '...with what the student already knows...' (Petrie, op. cit., 440), because the linear design process model expected students to satisfactorily cope with the initial stages of conception and planning *before* having had the experience of making anything or acquiring any necessary tool skills; *before* they had had opportunities for '...recalling...[or]...recognising...' (Cronbach op. cit., 555) *any* solutions, much less '...inventing alternative solutions...' (ibid.). The conventional design process model was being applied in a learning context, yet it seemed to assume that students' reactions would exhibit the '...mark of the expert...' (ibid.). Students' readiness (ibid., 78-79) for application of the conventional design process model seemed at odds with its cognitive demands. There appeared to be preoccupation in the design line about '...what children and young people WILL learn without matching attention to what they CAN learn' (Baynes, 1990, 42). Quite simply, the linear design process '...is really just *a convenient shorthand* for designers...' (Liddament, 1990, 41), not, as confirmed by my earlier experience, a pedagogy for design education.

In re-setting the problem, I removed the making stage from the design line, and at the same time, overlaid it with the two thinking skills, convergent thinking and divergent thinking. Thus, I had a restated design process which positioned the remaining four design stages in congruence with the thinking skills required for them. Figure 3 illustrates the design line adjusted for thinking.

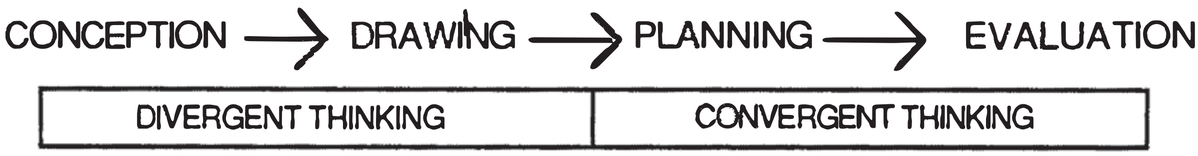


FIGURE 3: **THE DESIGN LINE ADJUSTED FOR THINKING**

This model of the design line adjusted for thinking allowed me clarity of thought in terms of the relationships of divergent and convergent thinking to the four design stages of conception, drawing, planning, and evaluation, but it seemed to offer little pedagogical utility in terms of the *Design in Metal* syllabuses where students were expected to

'...[work]... through the design process to solve problems' (Tasmania, 1991, 3), to '...[demonstrate]...an understanding of the design process in the workshop through the production of work undertaken...' (ibid., 3), and to '...[apply]...the design process in the development of student-initiated tasks' (ibid., 3). The design process as expressed in the syllabuses quite firmly incorporated the making stage in its requirements for assessment; students were expected to make something, most usually an artefact, although a system or a model would also satisfy the syllabuses' requirements. Nevertheless, tool skills were required for design realisation in the making stage, consequently this restatement of the problem needed more refinement.

Because of its possession of both divergent and convergent thinking, making is a microcosm of the design process. At various stages in making something there is a need to recall, reorganise, and invent (Cronbach, op. cit., 554), and to simultaneously '...reduce the array of possibilities...' (ibid., 555). From the standpoint of intellectual development, making develops abstract thinking through reading working drawings and consideration of resultant scale and analogue models and symbolic interpretation of language (Black, op. cit., 220-223). In its heuristic use of language, making, as pointed out above, does lead to the formation of '...fully abstract categories, categories capable of dividing the phenomena into the "x" and "not x" at successive stages of generality' (Britton, op. cit., 213). Thus, in terms of the design process, making is a separate, but connected entity. This is, I believe, the basic shortcoming of the conventional design process; that making is '...equated with other stages in the process' (Dodd, op. cit., 27). Accordingly, in constructing an alternative design process model, making needs to be placed in a separate but connected position in relation to the other stages. Making needs to be placed centrally to achieve these structural relationships in the model. In my embryonic alternative design process model, making was placed in a circle; the making cell.

FIGURE 4: **THE MAKING CELL**

Moreover, by placing making at the centre of the design process, a closer representation of its place in the classroom designing and making procedure is achieved. Most of the classroom time spent in designing and making is taken up by making. From a pedagogical point of view, making initiates readily identifiable task activity in the classroom, and provides an opportunity to evaluate students' potential for further design based work.

Contemporary thought about teaching in design activities acknowledges the value of processes such as making. Hooper, for example, points out that:

> ...genuine understanding can come from simply manipulating materials. We should be prepared to copy a piece of craftsmanship, make a specific joint in isolation, or make a model purely to explore the parameters of model making if in so doing we are extending pupils understanding and ability to realise their own ideas (op. cit., 170).

Thus my alternative model of the design process began to take shape; the design line model was being replaced with the design circle. Figure 5 depicts the circular model.

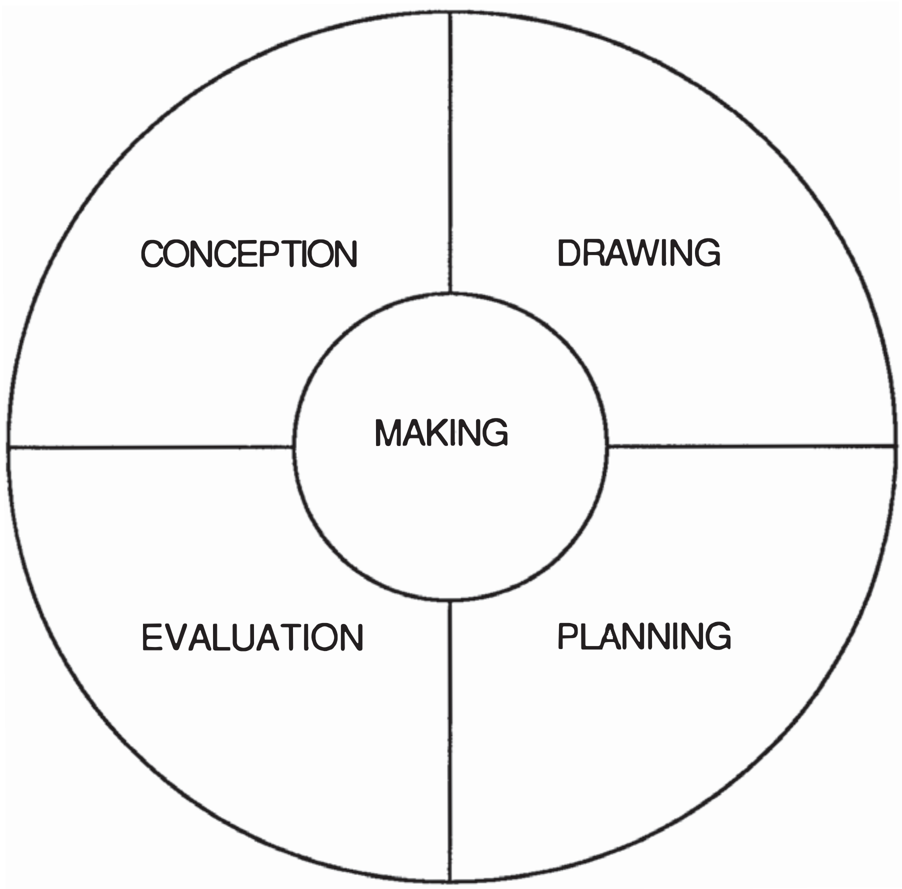


FIGURE 5: **DESIGN STAGES PERIPHERAL TO MAKING**

Because of their interconnectedness with each other and making, the other four design stages of conception, drawing, planning, and evaluation are placed peripherally around the making cell. This placement unlocks the temporally fixed contiguity of the linear design stages which has led to a presumption that they must be addressed in a step-by-step fashion. Like me, Chidgey found that his '...attempts to match CDT learning experiences with discrete stages common to various design process models were unsuccessful' (op. cit., 44). Thus, the model's second developmental stage of the making cell surrounded by the remaining design stages allows their simultaneous consideration with the making stage. The third and last stage of its development is the model's incorporation of divergent and convergent thinking skills at positions appropriate to the cognitive demands made on its users.

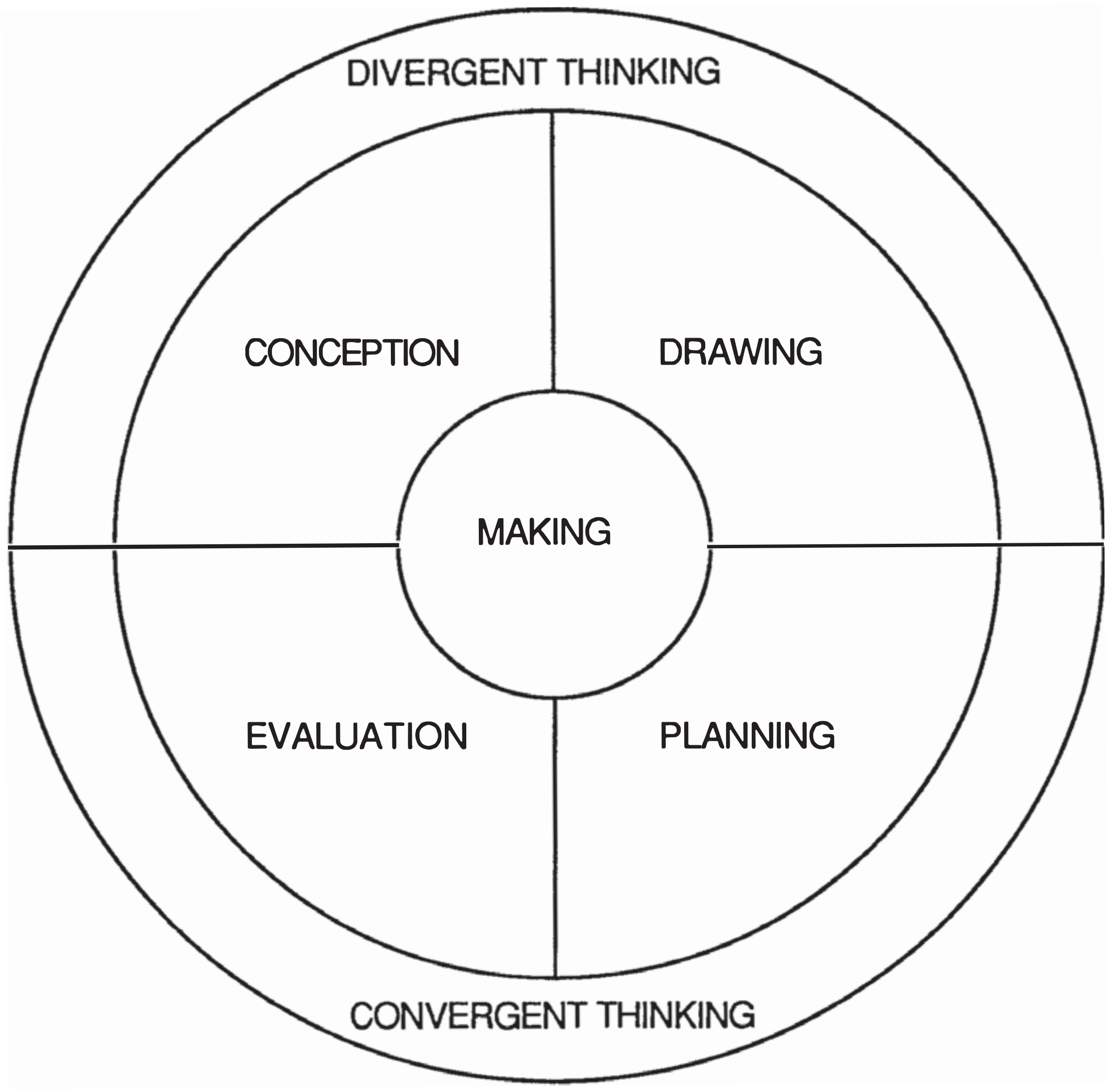


FIGURE 6: **DESIGN CIRCLE FOCUSED ON MAKING**

Thus, each design stage occupies a position which is radially connected to all others through the focus of the design episode, in this case, making. The peripheral but contiguous positions of conception and drawing allows them to be simultaneously linked to the divergent thinking skills which accompany their application, and similarly, planning and evaluation are simultaneously linked contiguously and to the convergent thinking skills accompanying their application. This re-setting of the design process problem revealed an alternative way of thinking about the design process; a *generative* metaphor (Schon, op. cit., 244-256): *design is a circle..*

Having established what I believed to be a more appropriate design process model in terms of an operational strategy, I decided to implement it in the classroom in a design episode which incorporated serially connected phases.

To begin the design episode, making occupied the centre of the circle, thus forming its focus (the dynamism inherent in the circular model which allows change of focus for different design episodes will be discussed below). Surrounding the making cell were the design stages of conception, drawing, planning, and evaluation, each linking radially to the central making stage. Entry for all students would be at the making stage, thus initiating student activity and allowing me to observe students' reaction and plan further design instruction accordingly. At the same time it would quickly establish a purposeful classroom climate and an active context for students' work.

To begin the design episode a completed G-clamp was presented to the group. Nothing was said about the conception, drawing , planning, and evaluation stages at this time. The G-clamp was presented as a finished artefact to be reproduced. The skills needed for its completion would be addressed in its copying and involved marking out, cutting, filing, drilling, tapping, lathe work (parallel and taper turning), heating and bending, and peening. Normatively speaking, most grade 9 students are capable of learning these tool skills and although I had no knowledge of students' specific backgrounds in the subject, my past experience led me to expect that the objectives were attainable. Moreover, these tool skills had been determined in the context of their teaching; the limited availability of certain tools and machines which would require temporal sequencing. The required material had been prepared, and I had made a jig to simplify the bending process.

As students completed the G-clamp I asked them to address the design stage of planning by working radially from the finished product, in other words an analysis and documentation of what had been done in order to make a copy of the G-clamp. I then asked for another radial connection to the drawing stage; to draw the finished artefact. Finally, another radial connection was made to the evaluation stage, an expression of the artefact's worth. Liddament supports this action when he says that 'it is far sounder, in the initial stages in the teaching of design, to get pupils to evaluate existing artefacts' (1990, 41). These events marked the end of the first phase of the design episode.

The second phase involved conceiving, drawing, planning, making, and evaluating a nut cracker. It was intended as an exercise in the more abstract, divergent thinking required for the conception and drawing stages, and the more concrete, convergent thinking required for the planning and evaluation stages of the design process. One reason for making the G-clamp had been to establish and develop the tool skills necessary for its realisation, but more importantly it provided an analogue model; a model sharing with the nut cracker'...the same structure or pattern of relationships' (Black, op. cit., 223). The analogy lay in its structural and mechanical principles: the nut cracker would consist of a frame against which a threaded component could be forced by screwing thus exerting a force capable of cracking the shell of a nut. At this stage no concrete or real expression of the nut cracker existed; there was no artefact or model made. The nut cracker was an abstract objective, not a reality. Limitations for its design and realisation, however, were set to be exactly as those set for the G-clamp; it would be made from the same materials fashioned by the same tool and machine processes. As Mayall says:

> The designer is always limited by the materials, tools and skills at his disposal. These provide the framework within which he creates his product. And the history of product development is very largely the history of enlarging this framework; from the use of stones and the crude chipping of early man to the diversity of natural and synthetic materials, powered tools and the specialised skills of today. (op. cit., 11 - 12).

Thus, my aim was to recreate a microcosm of those developmental stages; of the reality of design limitations in the classroom, by imposing limitations which were expressed in the design brief as:

> Using no more than the identical types and quantities of materials and processes used to make the G-clamp, design and make a device capable of cracking the shell of an edible nut such as a walnut or macadamia nut so that the kernel may be removed and eaten.

This time the conception stage of the design process was focused. It occupied the centre of the design circle. In its occupation thus, conception invited radial connections to the surrounding elements, allowing them to be considered simultaneously rather than as temporally, contiguously fixed '...discrete stages...' (Chidgey, op. cit., 44).

This action facilitated students' simultaneous consideration of various contextual limitations such as their level of tool skill development, availability of materials, tools and machines before commitment to succeeding stages; and the presence of their analogue model provided credible boundaries to the design episode. Figure 7 illustrates the design circle focused on conception. Photographs and documentation of the work of one student, a grade 10 boy with grade 9 experience in the subject are attached in the Appendix.

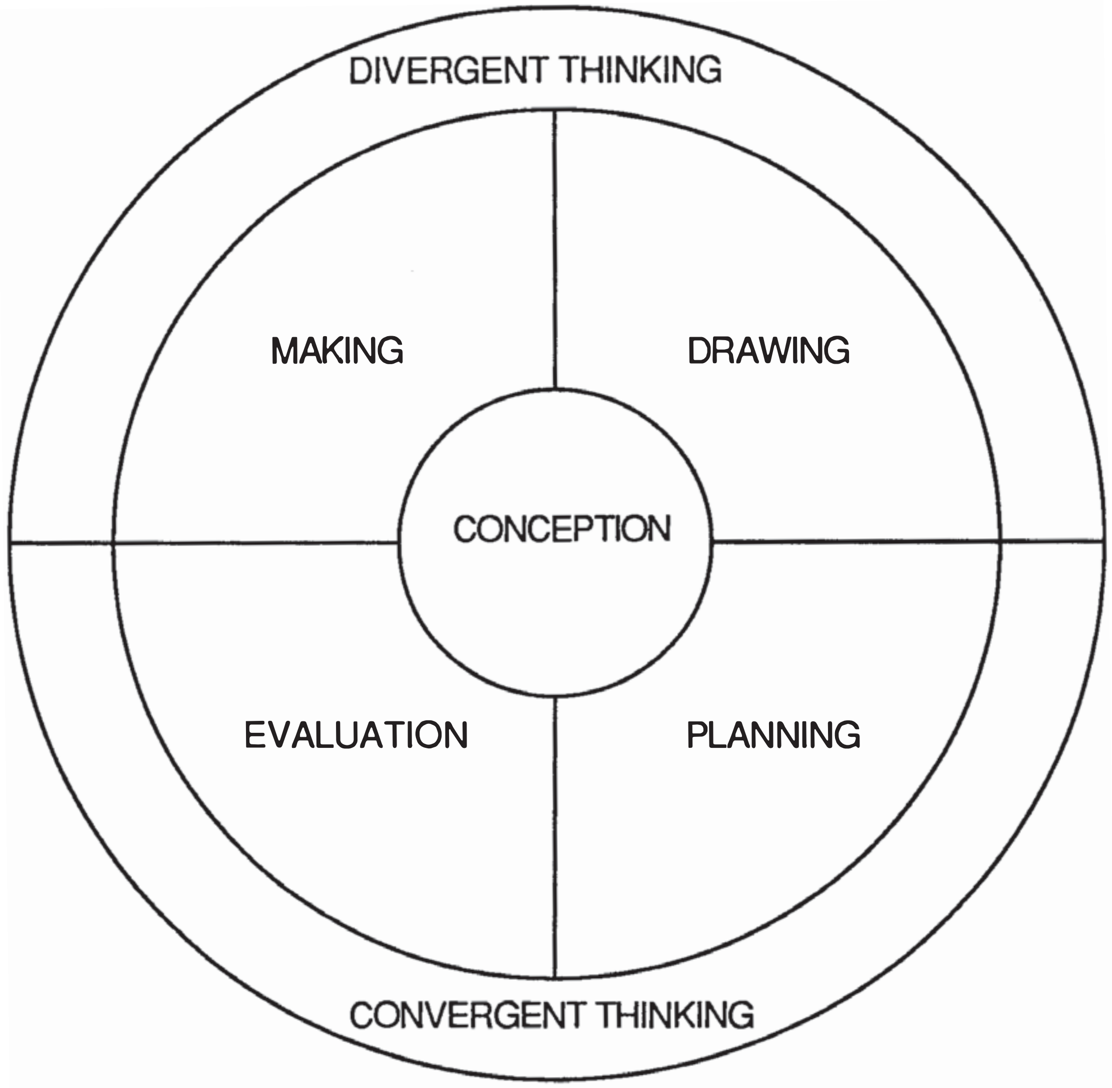


FIGURE 7: **DESIGN CIRCLE FOCUSED ON CONCEPTION**

Thus this design episode replaced the conventional linear design process with an alternative radially connected circular structure which obviated the abstraction associated with the conception stage by allowing entry to the design episode at the making stage; a stage which provided significant cues for students. These cues were signposts which marked the way and enabled students to develop and gain experience in a controlled fashion. These signposts will enable students' design framework to be enlarged accordingly as their tool skills mastery and design competence develop in tandem.

For example, as illustrated above, some students may enter subsequent design episodes at the conception stage once their tool skills mastery and design competence is established. Others may need more time and may require several more design episodes which begin with the concreteness of the application of convergent thinking skills in the making stage linking to the planning and evaluation stages followed by radial links to the more abstract conception and drawing stages. For some, connection to the drawing stage may provide opportunities to address the skills necessary in reading working drawings; making by copying an artefact may be replaced with making from a working drawing. Most importantly though, all will be reaping the rewards of their own labours, their work will be their own because their development of tool skills and their application has proceeded in a controlled fashion according to the individual expansion of their design frameworks; expansions which will address students' ability to work '...creatively and solve problems...to use ideas and materials inventively - recombining ideas to meet new situations and contexts, and extrapolating beyond what has been given explicitly' (Tasmania, 1987, 17-18).

Thus, by re-setting the problem of deriving a pedagogy from the design process through the examination of the metaphor underpinning the conventional design process model, and replacing it with another metaphor which generated an alternative design process model, I was able to free myself from certain assumptions and prejudices about design education which earlier had led me to dismiss it as unworkable in a pedagogic sense. Much of the literature cited here dwells on just this difficulty; the difficulty of recognising that some teachers' thinking is locked into a dichotomous assumption about teaching for tool skills development and teaching to a design orientation which leads to an inability to develop a pedagogy incorporating both. Metaphor has been instrumental in its role in developing this alternative pedagogy for design education. It remains now to examine how metaphor has been able to offer itself as such a powerful tool for thinking.

CHAPTER FIVE

METAPHOR: A POWERFUL SERVANT AND A CRUEL MASTER

This study has clearly demonstrated the value of metaphor in the development of pedagogy. It has shown the heuristic power of metaphor; a power to act as an agent for setting ideas and problems, of empowering teachers to step beyond the imprisonment of their language and construct meaning from their interpretations of syllabus prescriptions. Analysis of metaphors underpinning conceptual models has helped '...to notice what otherwise would have been overlooked, to shift the relative emphasis attached to details - in short, to *see new connections* ' (Black, op. cit., 237). At the same time though, it has highlighted the limitations of metaphor, particularly where a metaphor becomes uncritically accepted. Discrimination is essential for the application of metaphors as tools for thinking; discrimination between dead metaphors and active metaphors. Such distinction has been demonstrated in this study where the uncritical acceptance of a dead metaphor led me to certain literal assumptions about its modelling of a process, which, in turn, led to a denial of the process itself; and my subsequent re-setting of the problem in terms of another metaphor which enabled the generation of an alternative model.

Metaphorical models such as the linear design process are valuable to the extent that they are '...instruments of exploration and discovery...' (Pratte, op. cit., 312), but they lose their value and become misleading or even dangerous if they are allowed to assume the status of the thing for which they stand; that 'what had before been models are now taken for the things modeled [*sic*]' (ibid.). By making a metaphor '...too important by definition...[it narrows]...our view of the subject excessively' (Black, op. cit., 45).

Because of its limited usefulness in teaching, the linear design process described above is one such model which is '...now taken for the things modeled' (Pratte, op. cit., 312) because the metaphor underpinning it is a dead metaphor, and a dangerously dead one at that. The linear design process has '...been used so often that speaker and hearer have ceased to be aware that the words are not literal' (Nicholson, cited by Bouson, 1980, 34), and it is '...is assumed...[to be]...literal in the sense that the metaphor is not noticed at all' (Pratte, op. cit., 310). That it is not noticed is demonstrated by its typical acceptance as shown above. *Design is a line* is a well-entrenched concept in both the literature and practice of design education, but as revealed above, its pedagogical utility is limited.

Because the design process has become literally interpreted as linear, the danger lies in the belief that that is its only possible interpretation. As I have shown above, this assumption leads to pedagogical conflict resulting in hostility and rejection by some teachers in the design education field. Moreover, not only has the design line metaphor died through overuse and uncritical application, but arguably its demise has been hastened by unsuccessful attempts to shore it up in the face of increasingly legitimate criticism; it is a slain metaphor.

The two killers of the design line metaphor are firstly, the fact that it has been used '...to stipulate a definition...' (Bouson, op. cit., 35), of design, and secondly, the fact that it has been used '...to explain away the incongruity...' (ibid.) between it and the reality evident in its application. The modus operandi of the first of these two killers is well described above. The design line's linear structure was implied by many writers (Dodd, op. cit., 45; Eggleston, op. cit., 23; Green, op. cit., 13; Toft, op. cit., 9; Zanker, op. cit., 16), and was rendered explicit by Dodd's declaration of it as the '...logical sequence of the design-line...' (op. cit., 55). The concept of design modelled by a line was allowed to become the concept itself; thus the design process was defined as linear.

The second killer's method of operation is more subtle. In the face of repeated failure by students to progress beyond the several temporally fixed contiguous design stages in the divergent thinking area, the model was altered '...to explain away the incongruity...' (Bouson, op. cit., 35). This incongruity was explicitly evident in the gulf between the model's promise of design success and its failure to deliver; and implied by the mis-match between students' cognitive development and their expected performance in its early stages. The attempt to '...explain away...' (ibid.) these failures of the model was manifested in the superimposition of other linear structures on the model to retrospectively link the design stages in the event of a process breakdown at any one stage (Green, op. cit., 16; Dunn, op. cit., 18; Liddament, op. cit., 40) or by '...sliding back a little from the extreme end...' (Kimbell, op. cit., 29) or even by recognising the model's incongruity with reality by noting in the model itself the failure of its users to implement it in its intended fashion (Zanker, op. cit., 16). By endeavouring to explain away these incongruities; these qualifications to the model, the problems associated with incorporating the different types of thinking skills required into the design line remained unaddressed, and, as I have demonstrated above, the design line model failed to retain its cognitive integrity in the face of such unconvincing justification. Some, for example Dodd, Green, and Zanker have tried, but the resultant model is too unwieldy to offer a useful '...tool for the exploration and discovery of something explicit' (Pratte, op. cit., 312).

The alternative metaphor proposed here, that *design is a circle,* offers promise in application and development as a pedagogy for design education because its circular structure allows the temporally fixed contiguity between design stages of the conventional linear model to be unlocked, and through its radial connections simultaneous consideration of all five design stages is possible. The design circle offers the possibility of an answer to Chidgey's search for

> ...a more flexible framework...adopted to assist in developing the skills, attitudes, and knowledge associated with CDT, and may encourage teachers and pupils to concentrate their thoughts and efforts towards the design activity itself while providing the essential structure to aid and monitor progress (op. cit., 44).

Furthermore, the design circle goes some way to addressing the fluidity and interdependency of the design process recognised by Dunn (op. cit., 18), and readily accommodates the appropriate positioning of the different thinking skills required in the design process. Most importantly however, the design circle allows for a dynamism not possible in the linear model; a dynamism which enables the teacher to tailor the design process to the needs of individual students and to limit the implied shaping of students' thinking to fit a series of linear design stages which may create '...a setting that often subordinates individuality to aggregate "processing" ' (McNeil, 1987, 105).

This dynamism takes the form of resetting the focus of the design episode by interchanging the various design stages to the central position in the model. As demonstrated in the case study (Appendix), a design episode can be serially linked in a phased fashion by radially connecting the various design stages to the focus, in that case, the design stage of making. But, as demonstrated in the second phase of that design episode, the circular design model can be refocused; the focus can be occupied by conception, or in other instances, drawing, planning, or evaluation, depending on teachers' purposes for the design episode. Thus the design circle's interconnectedness and its dynamism accord it a vitality and vigour unknown in the design line metaphor. The design circle is underpinned by an active metaphor; and its application demonstrated here has peeled back only the first layers of its potential to be a powerful thinking tool in areas beyond the immediacy of this study.

In developing a pedagogy for design education, however, the design circle metaphor empowers teachers; it enables them to retain the *what, how,* and *when* of their teaching by providing a more appropriate metaphor for the presentation of the design process; not only for their students, but more importantly, to facilitate and guide their own thinking, their critical reflection; where the statement of '...a fact of which we are aware...' (Langer, op. cit., 114), is, by metaphorical analysis, found to contain, '...by implication, further facts of which we were not aware until we analysed our assertion' (ibid.).

BIBLIOGRAPHY

Baynes, K. "Towards Design Curriculum" *Industrial Arts Education*, Vol. 20, No. 3, September, 1982, 5-11.

Baynes, K. "Alice in Design and Technology Land" *Design & Technology Teaching*, Volume 23, Number 1, 1990, 38-42.

Black, M. *Models and metaphors*, New York, Cornell University Press, 1962.

Blishen, E. (ed.), *Encyclopedia of Education*, (1970), s.v. "Handicraft", 333-336.

Block, J. H. "Operating Procedures for Mastery Learning" Block, J. H. (ed.), *Mastery learning theory and practice*, New York, Holt, Rinehart & Winston, 1971, 64-76.

Booth, B. "The Development of Technology Education in the United States" *Design & Technology Teaching*, Volume 22, Number 1, Spring, 1990, 45-50.

Bouson, R. *Metaphor and simile* Ann Arbor, University Microfilms International, 1980.

Brady, L. *Models and methods of teaching* Sydney, Prentice-Hall, 1985.

Britton, J. *Language and learning* Harmondsworth, Penguin, 1972.

Chidgey, J. "A Critique of the Design Process" *Design Technology Teaching*, Volume 22, Number 1, Spring, 1990, 43-44.

Clandinin, D. J., *Classroom practice*, London, The Falmer Press, 1986.

Cronbach, L. J. *Educational psychology*, New York, Harcourt Brace Jovanovich, 1977.

Deighton, L.C. (ed.), *The Encyclopedia of Education*, Vol. 5, (1971), s.v. "Industrial Arts Education: Curriculum Developments", 13-19.

Deighton, L. C. (ed), *The Encyclopedia of Education*, Vol. 5, (1971), s.v. "Industrial Arts Education: History", 33-35.

Dodd, T. *Design & technology in the school curriculum,* London, Hodder and Stoughton, 1983.

Dunn, S. *Craft design and technology* London, Unwin Hyman, 1989.

Eggleston, J. *Developments in design education,* London, Open Books, 1976.

Glenister, S. H. *The technique of craft teaching (woodwork and metalwork),* London, George C. Harrap, 1968.

Green, P. *Design education problem solving and visual experience,* London, Batsford, 1978.

Guy, P. K. "Design in Secondary Schools" *Industrial Arts Education,* Vol. 19, No. 4, December, 1981, 33-35.

Guy, P. K. "The Role of the Teacher in Design" *Industrial Arts Education,* Vol. 20, No. 3, September, 1982, 23-24.

Hanks, K and Belliston, L *Design yourself,* Kaufmann, 1978.

Heskett, J. *Industrial design,* London, Thames and Hudson, 1980.

Hogan, G. "Industrial Arts Design" *Industrial Arts Education,* Vol. 24, No. 4, December, 1986, 17-20.

Hooper, J. "CDT: Missing the Point?" *Design & Technology Teaching,* Volume 22, Number 3, 1990, 170-176.

Hughes, M. "Effective Management in CDT" *Industrial Arts Education,* Vol. 27, No. 1, March, 1989, 5-9.

Jackson, B. "Lowered Expectations: How Schools Reward Incompetence" *Phi Delta Kappan,* Vol. 67, No. 4, December, 1985, 304-305.

Kimbell, R. *Design education,* London, Routledge & Kegan Paul, 1982.

Lakoff, G. and Johnson, M. *Metaphors we live by,* Chicago, University of Chicago Press, 1980.

Langer, S. K. *Mind: An essay on human feeling* Vol. 1, Baltimore, Johns Hopkins, 1967.

Liddament, T. "Putting Design in CDT" *Design & Technology Teaching,* Volume 22, Number 1, Spring, 1990, 40-42.

Liddament, T. "The Role of Modelling in Design and Technology" *Design & Technology Teaching,* Volume 22, Number 3, 1990, 153-156.

Maldonado, T. "Design Education" *Education of vision,* Kepes, G. (ed.), New York, George Braziller, 1965, 122-135.

Mayall, W. H. *Industrial design for engineers,* London, Iliffe Books, 1967.

McNeil, L. "Talking about differences, teaching to sameness" *Journal of Curriculum Studies* Vol. 19, No. 2, 1987, 105-122.

Petrie, H. G. "Metaphor and Learning" Ortony, A. (ed.), *Metaphor and thought,* Cambridge, Cambridge University Press, 1979, 438-461.

Pratte, R. "Metaphorical Models and Curriculum Theory " *Curriculum Inquiry,* 11:4, 1981, 307-320.

Pye, D. *The nature and art of workmanship,* London, Studio Vista, 1971.

Random House Dictionary of the English Language, New York, Random House, 1968.

Reddy, M. J. "The Conduit Metaphor - A Case of Frame Conflict in Our Language about Language" *Metaphor and thought,* Ortony, A. (ed.), Cambridge, Cambridge University Press, 1979, 284-324.

Schon, D. "Generative Metaphor: A Perspective on Problem-Setting in Social Policy" *Metaphor and thought,* Ortony, A. (ed.), Cambridge, Cambridge University Press, 1979, 254-283.

Shulman, L. "Knowledge and Teaching: Foundations of the New Reform" *Harvard Educational Review,* Vol. 57, No. 1, February, 1985, 1-22.

Tasmania, "The Project -- Out or Redirected", "The Future of Manual Arts and Industrial Arts", Education Department, Tasmania, 1971.

Tasmania, *Scott Report,* report of the committee on secondary education, Education Department, 1977.

Tasmania, *Secondary education: the future,* Education Department, Tasmania.

Tasmania, *School certificate Handbook for 1986-87* The Schools Board of Tasmania, 1986.

Tasmania, *Tasmanian Certificate of Education Materials, Design and Technology Subject Handbook,* The Schools Board of Tasmania, 1991.

Toft, P. *Craft, design and technology for GCSE,* London, Heinemann Educational, 1987.

Tom, A. R. *Teaching as a moral craft,* New York, Longman, 1984.

Tiberius, R. G. "Metaphors Underlying the Improvement of Teaching and Learning" *British Journal of Educational Technology,* No. 2, Vol. 17, May, 1986, 144-156.

Webberley, B. *Design projects metal craft & technical drawing* Hobart, Clarence High School Presentation, 1986.

Webster's New Dictionary and Thesaurus, New York, Russell, Geddes & Grosset, 1990.

Welch, A. "Design realisation through mastery learning", unpublished B.Ed. project, Centre for Education, University of Tasmania, 1990.

West, D. J. "CDT: is it 'Hands on' or 'Hands off'?" *Design Technology Teaching,* Volume 22, Number, 1, Spring, 1990, 38-39.

Weston, R. F. "Defining Design and Technology" *Design & Technology Teaching,* Volume 23, Number 1, 1990, 31-34.

Wilber, G. O. and Pendered, N. C. *Industrial arts in general education,* New York, Intext Educational, 1973.

Zanker, F. *Design and craft in education,* Leicester, Dryad, 1979.

APPENDIX

A CASE STUDY

The accompanying illustrations, photographs, and copies of design process documentation are taken from one student's responses to the design episode described in Chapter Four. Figure 8 is a photograph of his completed G-clamp, and Figure 9 is a photograph of his completed nutcracker. His documented responses to the design process in both phases of the design episode are shown on the attached pages copied from his exercise book.

As the photographs show, he has successfully made both artefacts. They are real, and function as intended. In his documentation he describes the various metalworking processes he used to make the G-clamp and finishes with an evaluation of it, saying 'The only thing I would do differently would make the fram of the G clamp out of a hever gauge metal other than that I wouldn't do it any differently [*sic*]'. His drawing is reasonably well done, although his apparent lack of knowledge in that area led him to make a pictorial drawing rather than adopting the more generally accepted two or three view orthographic projections used for working drawings. Details of the way the foot of the clamp was fastened to the end of the screw thread is not clearly depicted; its communicative intention is not realised, and it is unlikely that someone else could use it in its present form to make another.

His drawing for making the nut cracker shows a generally closed shape with a widened and raised portion at the bottom, presumably to site the nut as it is being cracked. Closing the frame thus and making the widened site for the nut required a skill in welding which was outside the framework for the design episode. After discussion with me, he came up with the open triangular shape shown underneath his first drawing which eliminated the need for welding.

As the photograph of the nutcracker shows (Figure 9), he altered the triangular shape during its making when the level of abstraction was reduced from that represented by the drawing, the scale model (Black, op. cit., 220) to that represented by reality. The circular design process had also allowed him to cognitively link back radially to the conception stage whilst operating in the making stage, and when he realised that there was nowhere for the nut to be securely sited whilst it was cracked, he simply straightened the frame and bent the apex of the triangle twice, thus producing the completed truncated triangular shape shown in Figure 9. He acknowledges this design amendment in his evaluation when he says '...the only thing that had to be changed was the shap of the fram of the nut cracer [*sic*]'.

This student is typical of those whom I have taught in metalwork over the past 17 years; the '...less articulate secondary students...' (Eggleston, op. cit., 8-9). Literacy and verbal ability are not his strengths. He enjoys working with metal however, and is quite able to demonstrate his competency in a practical fashion by making things and, as shown above, by designing things, but I believe that in the linear design model his limited skills of self-expression would have stalled him at the documentation stages of the linear design process. Had I initially waited for him to put his ideas down on paper before discussing them (Kimbell, op. cit., 45), instead of having him work through the exemplar, then I believe that his task of self-expression would have been more difficult for him than it was. Furthermore, had I stuck rigidly to the design line, his alteration during making would have necessitated a reactive linking back to the conception stage, temporally followed by revised drawings and planning statements. Given his ability in the latter two areas, he could easily have become alienated and disaffected towards the entire design episode.

From my pedagogical perspective, this case study revealed the value of the design circle in allowing me to start all students at a common point, making, where the opportunity exists to vary the cognitive demands in concert with students abilities. The wide range of ability and experience in the group needed to be quantified; I needed time to come to know my students and having them engaged on making something was a good way to do it. Moreover, I needed to rein in the range of workshop processes being used in accordance with factors such as the levels of maturity shown by the students, availability of resources such as tools and machines, and my desire to temporally sequence accesss to them. In short, I needed to establish a design framework for the first episode. An immediate launch into the linear design process would have seen me lose control over many of these factors, and once again revert to the anarchic classroom climate described in Chapter Three. Finally, the design circle enabled me to enter students at different stages in subsequent design episodes. Those students who needed more concrete expressions of their tasks could be readily accommodated in the making focus and still address the other design stages radially from there; those who had developed more abstract thinking skills could focus their design work on stages such as conception and drawing. Thus, in terms of both a pedagogy and a learning episode, the metaphor *design is a circle* is heuristically more effective than that of *design is a line*.

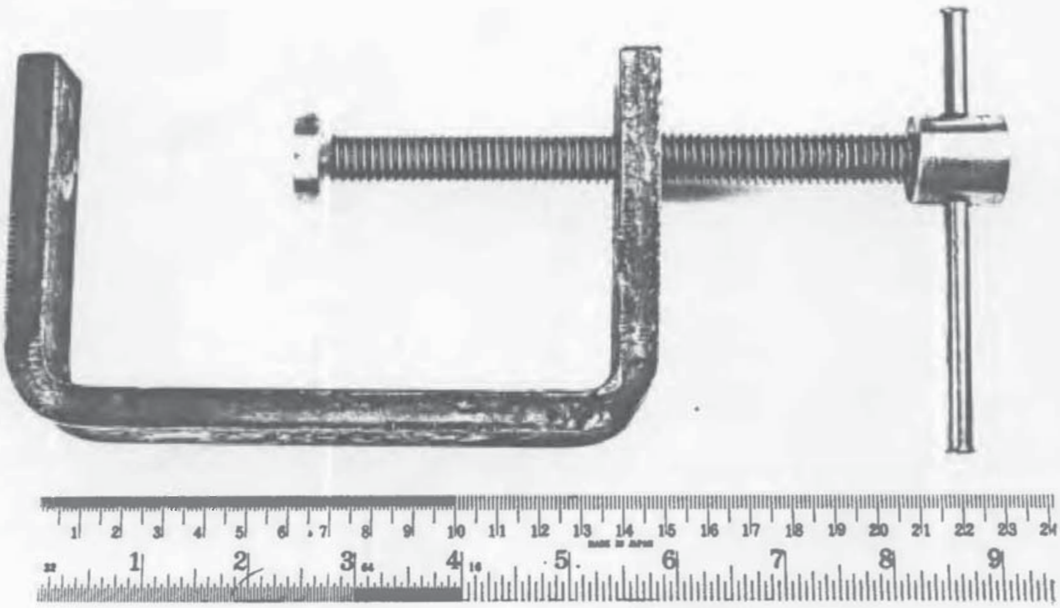


FIGURE 8: G-CLAMP

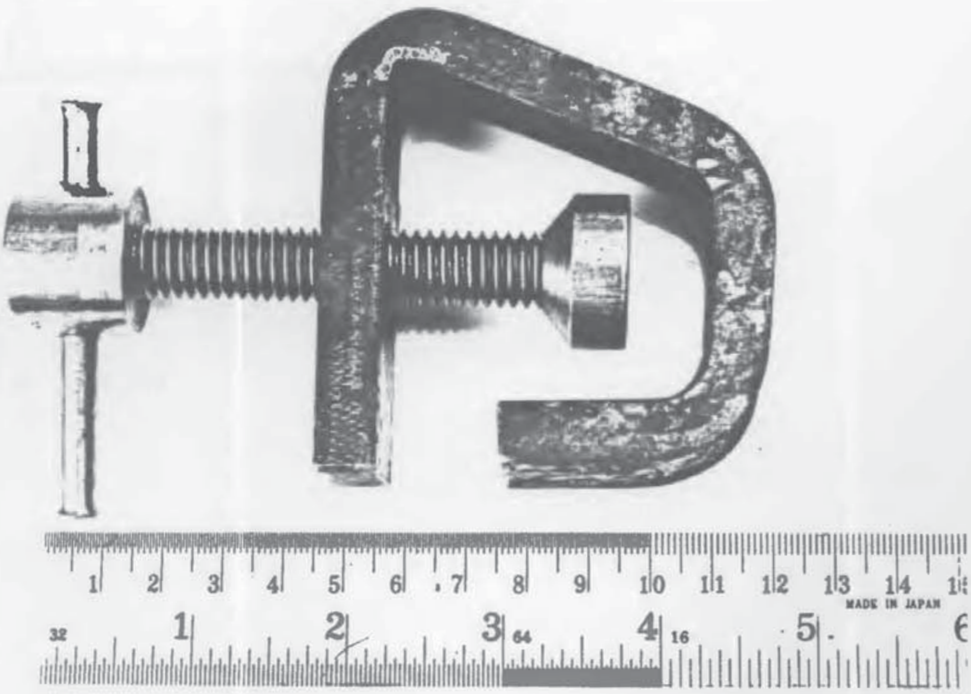
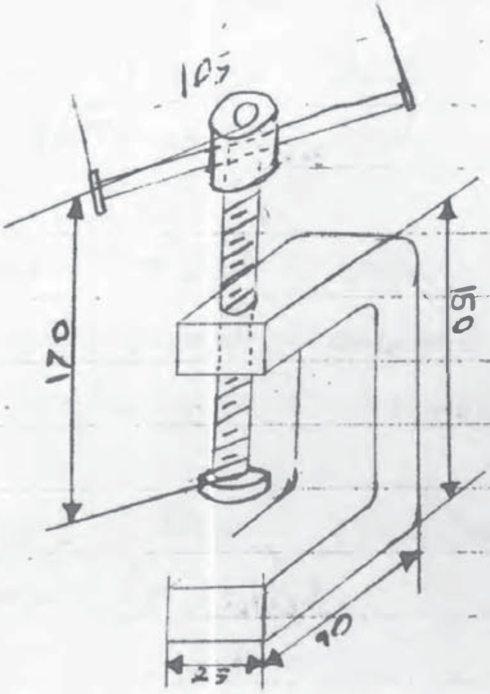


FIGURE 9: NUT CRACKER

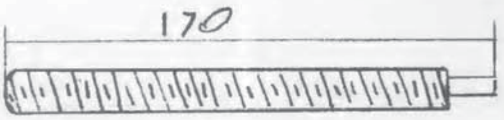
G Clamp



Boss

Foot

Thread



Prosese used

Heating and benting
Drilling
Riwitting
Tapping
Lath work.

G Clamp

1 Bend Steel bar to requied shap.

2 Turn boss down to 25 round with a 10.5 mm hole and tap it.

3 Turn foot down to 25 round and to requied sap with a 6.5 hole in it.

4 Turn the end of the thred down to 6.5

5 Drill a 10.5 hole in the bar and tap it.

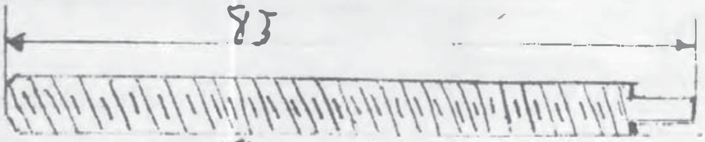
6 Atach the therd to the bar by scrawing it in.

7 Attach the foot by placing the foot over the machened end of the thred and riviting the end over.

8 Screw the Boss on the other end and drill a 6mm hole threw the side and put a small 6mm bar in and rivet each end over.

The only thing I would do differently would make the fram of the G clamp out of a heva gaje metel. other than that I wouldn't do it any differently.

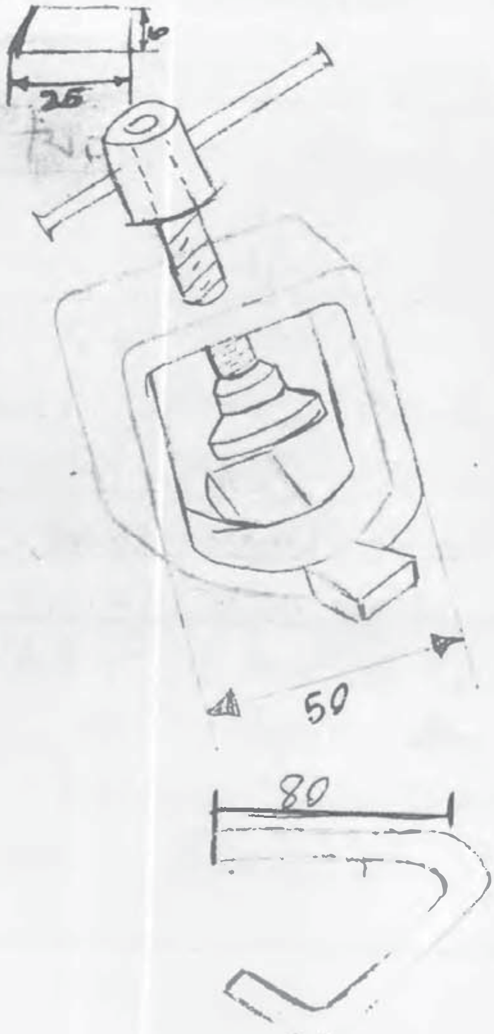
Nut Cracker

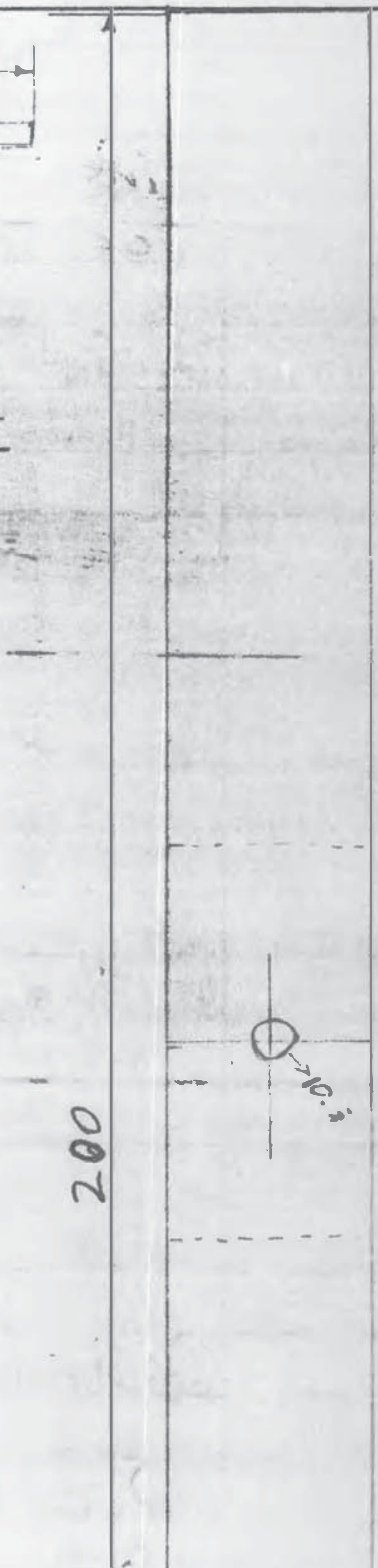


Thread

Boss

Base sides





Nut Cracker

step
1 Bend steel bar to requiad shap.
2 Turn boss down to 25 rand with a 10.5 hole and tap.
3 Turn foot down to 25 round and to the requiad sap with a 6.5 hole in it.
4 Turn the end of the thred down to 6.5.
5 Drill a 10.5 hole in the bar and tap it.
6 Atach the therd to the bar by scrowing it in.

7 Atach the foot by placeing the foot over the machined end of the thred and rividing the end over.
8 Screw the Boss on the other end and drill a 6mm hole threw the side and put a small 6mm bar in and rivet each end over.

The final product turned out just rite the only thing that had to be changed was the shap of the fram of the nut cracer.